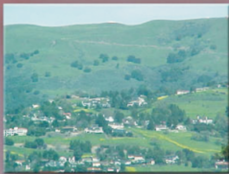
CITY OF MORGAN HILL

Sewer System Master Plan





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January 2002

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City of Morgan Hill

SEWER SYSTEM MASTER PLAN

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January 9, 2002
6179A.00 T02

City of Morgan Hill
17555 Peak Avenue
Morgan Hill, California 95037-4128

Attention: Mr. Jim Ashcraft, Director of Public Works/City Engineer

Subject: Sewer System Master Plan - Final Report

Dear Mr. Ashcraft:

We are pleased to submit the final report for the City of Morgan Hill Sewer System Master Plan. The report presents master planning assumptions, existing sewer system capacity evaluation, recommended facility improvements, and a capital improvement program to the planning horizon year 2020. The report is organized as follows:

Chapter 1 - Introduction
Chapter 2 - Planning Area Characteristics
Chapter 3 - Planning and Design Criteria
Chapter 4 - Existing System and Hydraulic Model
Chapter 5 - Evaluation and Proposed Improvements
Chapter 6 - Capital Improvement Program

We would like to extend our thanks to you, Ms. Alice Tulloch, Ray Dellanini, Julie Behzad, and other City staff whose courtesy and cooperation were valuable components in completing this study and producing this report.

Sincerely,

CAROLLO ENGINEERS, P.C.

Thomas S Kalkman

Thomas S. Kalkman, P.E.

Tony Akel

Tony A. Akel, P.E.

TSK/TAA:cjp

Enclosures: Final Report

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City of Morgan Hill

SEWER SYSTEM MASTER PLAN

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Executive Summary

SEWER SYSTEM MASTER PLAN

This executive summary presents a brief background of the City's sewer system, the need for this sewer system master plan, proposed improvements to mitigate existing capacity deficiencies, and proposed expansion improvements. A summary of the capital improvement program costs, through the planning horizon year of 2020, is listed at the end of this chapter.

ES.1 STUDY OBJECTIVE

Recognizing the importance of planning, developing, and financing sewer system facilities to provide reliable and enhanced service for existing customers and to serve anticipated growth, the City initiated the preparation of this sewer system master planning study. The Sewer System Master Plan study has been coordinated with the preparation of the Water System Master Plan and the Storm Drainage System Master Plan, which were concurrently completed by Carollo Engineers.

The objective of the study included the following tasks:

- Establish sewer system design and planning criteria.
- Review Infiltration and Inflow Flow Monitoring Data performed by another Consultant.
- Evaluate the capacity of the existing sewer collection system using computer hydraulic modeling.
- Summarize existing system deficiencies and propose improvements to enhance system reliability.
- Recommend improvements needed to service anticipated future growth.
- Develop a Capital Improvement Program with a planning horizon year of 2020.

ES.2 STUDY AREA

The 2001 General Plan Update developed by Crawford Multari & Clark Associates (Draft report dated March 2001), identifies the current boundaries of the Urban Growth Boundary (UGB), as shown on Figure ES.1. The City's sewer collection system master plan identifies the infrastructure necessary to service developed lands within the UGB. According to the General Plan, areas outside the UGB are intended to remain rural and unincorporated for the next 20 years.

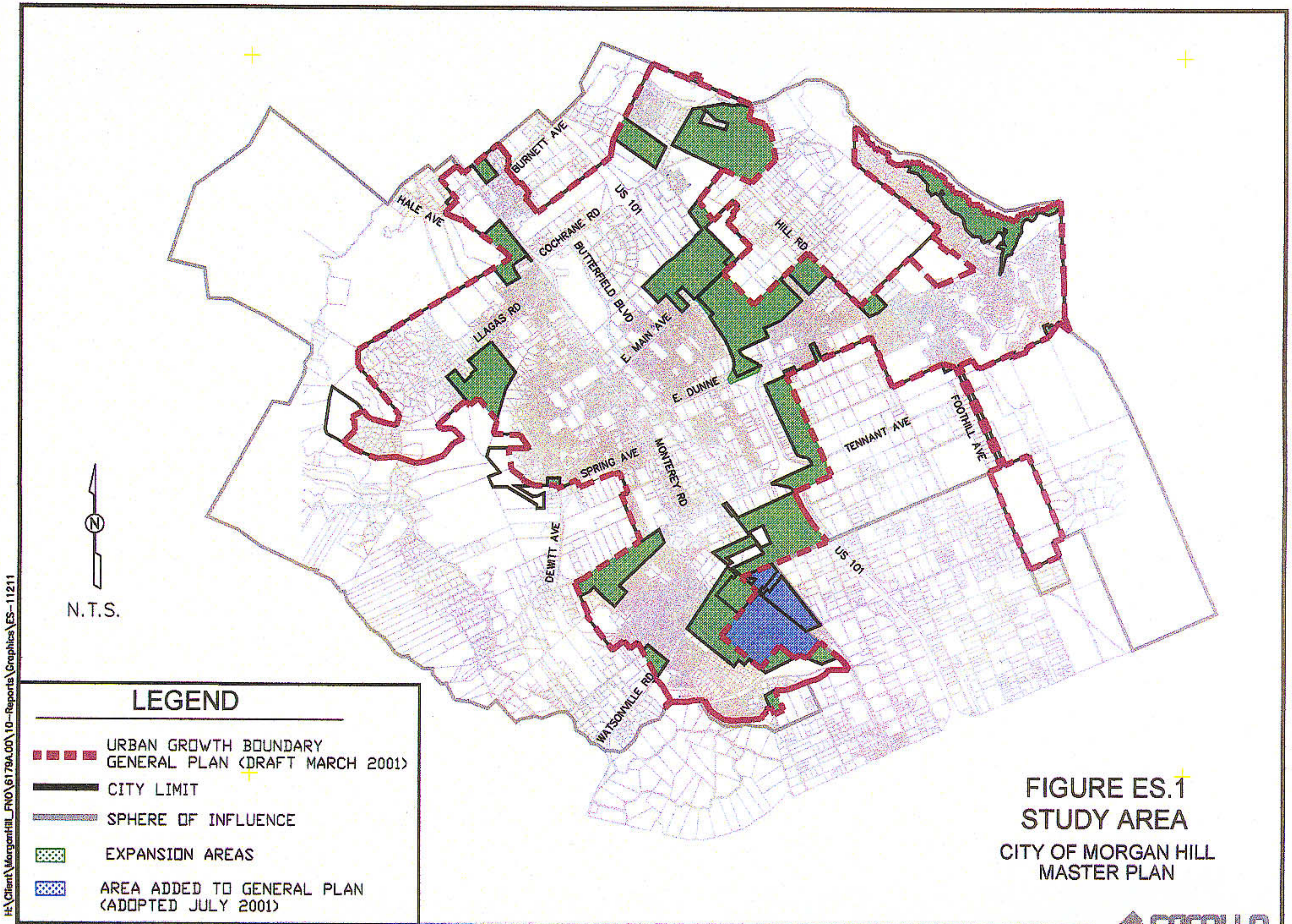


FIGURE ES.1
STUDY AREA
CITY OF MORGAN HILL
MASTER PLAN

The City's General Plan Update assumes that the current residential growth control will remain through the planning horizon year of 2020, yielding an average annual growth rate over the next 20 years of 1.8 percent. The General Plan Update further projects population ceilings of 38,800 and 48,000 for the years 2010 and 2020, respectively.

ES.3 SEWER SYSTEM OVERVIEW

The City of Morgan Hill sewer collection system consists of approximately 135 miles of 6-inch through 30-inch diameter sewers, and includes 15 sewage lift stations and associated force mains. The "backbone" of the system consists of the trunk sewers, generally 12-inches in diameter and larger, that convey the collected wastewater flows through an outfall that continues south to the Wastewater Treatment Facility (WWTF) in Gilroy.

Flow diversions serve the purpose of routing flows to relieve sewer trunks capacity limitations. The City's sewer system includes two active diversions along the trunk sewer system. The East Dunne Avenue Diversion is located on East Dunne Avenue, at the intersection with Hill Road. The diversion is currently configured to route the majority of sewer flows from the east foothills to the Hill-Barrett Trunk, however some negligible flows continue to the East Dunne Trunk for pipe cleaning purposes. The West Main Avenue Diversion is located on Main Avenue, at the intersection with Monterey Street. The diversion is currently configured to route all flows to the Railroad-Monterey Trunk.

Most of the City is on relatively flat valley land, with some developments on the foothill areas both east and west of the valley floor. Serviced elevations range from approximately 350 feet on the valley floor to over 1,200 feet in the foothills.

ES.4 SEWER FLOWS

Historical flows at the wastewater treatment facility were reviewed and analyzed to determine daily, monthly, and seasonal fluctuations experienced by the sewer system. The Harding Meter, which measures sewer flows leaving the City of Morgan Hill, indicates that the year 2000 average flow was 2.9 MGD while the measured maximum day wet weather flow was 5.19 MGD.

Design flow criteria were developed for estimating the City's future sewer requirements and for evaluating the capacity adequacy of the collection system. The criteria also include developing an equation for estimating the Peak Dry Weather Flow (PDWF) which is used for designing the City's collection system. The peaking factor generally ranges between 1.5 and 3.0, depending on the size of the tributary area, with larger areas corresponding to smaller peaking factors.

ES.4.1 Dry Weather Conditions

During existing dry weather conditions, the average flow and peak hour flows from the City of Morgan Hill are 2.9 and 4.1 MGD, respectively. At buildout of the 2020 Urban Growth Boundary, the average and peak hour dry weather flows are anticipated to approach 5.2 and 6.9 MGD, respectively.

ES.4.2 Wet Weather Conditions

Wet weather flows are based on a recent infiltration and inflow analysis conducted by another consultant that included a temporary flow monitoring program between January 4 and April 17, 2001 (Appendix B). The infiltration and inflow analysis identified the wet weather flow components experienced in the existing system. Evaluating the capacity adequacy of the City's sewer system included applying a hypothetical 5-year 24-hour design storm that increased the currently experienced infiltration and inflows.

Should the design storm occur, the hydraulic model projects existing average and peak hour flows of 5.9 MGD and 12.0 MGD, respectively. Applying the same storm event during the buildout condition of the General Plan results with an average and peak hour flows of 8.1 MGD and 14.6 MGD, respectively. These projected wet weather flows assume no mitigation to the current infiltration and inflow rates.

However, the City has an aggressive wet weather program to reduce infiltration and inflows (RDII) that are currently experienced by the system. In accordance with City staff, this study assumes that the City's RDII will be reduced by approximately 50 percent by the year 2020. In that scenario, the wet weather average and peak hour flows for buildout of the UGB are reduced to 6.6 MGD and 10.0 MGD, respectively.

ES.5 SEWER SYSTEM EVALUATION

The City's sewer system was evaluated based on the analysis and design criteria defined in this study. A hydraulic sewer model was assembled and used in evaluating the adequacy of the City's sewer system. The hydraulic model combines information on the physical characteristics of the sewer system (pipe sizes, pipe slopes, pumps, etc.), and performs calculations to solve a series of mathematical equations to simulate flows in pipes.

The dry weather flows were estimated by applying land use coefficient factors, and a 5-year 24-hour storm event was used to simulate the wet weather flows.

ES.6 CONCLUSIONS

The analysis of the City's existing sewer system indicates that the collection system was well planned to meet the needs of existing customers. In fact, and in anticipation of future growth, City staff have planned and constructed sewer facilities in conjunction with new street construction.

Some project improvements proposed in this master plan are needed to mitigate flows caused by infiltration and inflows that occur during significant storm events. City staff have been diligently working to mitigate the impact of these flows through an aggressive wet weather program with a goal for reducing the infiltration and inflows by approximately 50 percent through the project horizon year of 2020.

ES.7 RECOMMENDATIONS

The vast majority of the proposed projects consist of new or increased capacity pipelines that are needed to extend service to currently undeveloped areas. These proposed improvements, which are discussed in detail in the report, are phased to provide capacity enhancements to the collection system before the anticipated developments. A summary of the improvements is provided herein:

- Continue with the aggressive Infiltration and Inflow reduction program
- Continue with sewer main rehabilitation and upgrades
- Install the planned new radio telemetry for enhancing the operation of the sewer facilities
- Construct 30-inch new sewer trunk to replace portions of the existing 21-inch Railroad-Monterey Trunk
- Construct 18-inch new sewer trunk and lift station to divert flows to the existing Butterfield Trunk
- Construct 24-inch new sewer trunk to parallel the existing Joint Morgan Hill-Gilroy Trunk
- Construct 18-inch new sewer trunk to replace portions of the existing 12- and 15-inch Hale-Monterey Trunk
- Upgrade the capacity of existing Lift Station H on Monterey Avenue
- Construct 21-inch new sewer trunk to continue the alignment of the Butterfield Trunk
- Construct 18-inch new sewer to replace portions of the existing 12-inch Hill-Barrett Trunk

ES.8 CAPITAL IMPROVEMENT PROGRAM

The cost estimates presented in the Capital Improvement Program have been prepared for general master planning purposes and for guidance in project evaluation and implementation. Final costs of projects will depend on actual labor and material costs, competitive market conditions, final project scope, implementation schedule, and other variable factors such as: preliminary alignments generation, investigation of alternative routings, and detailed utility and topography surveys.

Knowledge about site-specific conditions for each proposed project is limited at the master planning stage, therefore the Estimated Construction Costs include a 30 percent contingency to account for unforeseen events and unknown field conditions. The Capital Improvement Costs also include an additional 30 percent (applied to the Estimated Construction costs) for project-related costs, comprising of engineering, administration, construction inspection, and legal costs.

Table ES.1 Capital Improvement Program
Sewer System Master Plan
City of Morgan Hill

Planning Period	Year	Capital Cost	Current Users	Future Users
Short-Term Improvements	2002-2003	$999,000	$249,750	$749,250
	2003-2004	$2,476,000	$1,238,000	$1,238,000
	2004-2005	$16,048,000	$4,749,500	$11,298,500
Intermediate-Term Improvements	2005-2010	$10,230,000	$5,115,000	$5,115,000
Long-Term Improvements	2010-2020	$1,363,000	$681,500	$681,500
Total		$31,116,000	$12,033,750	$19,082,250

Note: Costs of the upgrades at the Wastewater Treatment Plant are excluded.

INTRODUCTION

This chapter presents the need for this sewer system master plan and the objectives of the study. A list of abbreviations is also provided to assist the reader in understanding the information presented.

1.1 BACKGROUND

The City of Morgan Hill (Figure 1.1) operates its own sewer system and associated infrastructure facilities and services customers within the City Limits in addition to some County areas adjacent to the City Boundaries. The previous sewer system master plan was completed March 1993 (1993 Plan) and included a capacity evaluation and recommended improvements. The 1993 Plan was based on planning assumptions and operational conditions that have since changed.

In 1996, the City Council adopted a long-term Urban Growth Boundary (UGB), which identifies lands intended for future urbanization within the Sphere of Influence (SOI). In the fall of 1998, the City appointed a General Task Force to oversee major revisions of the Morgan Hill General Plan. The Task Force defined an expanded set of community goals and proposed changes to the 1996 General Plan that were summarized in the General Plan Update (October 1999). Subsequently, the City embarked on a more comprehensive update to the General Plan and retained the services of the firm Crawford Multari & Clark Associates (CMCA). A draft version of the General Plan, dated March 2001, was released by CMCA and used in this study. The General Plan was subsequently adopted in July 2001.

1.2 SCOPE AND AUTHORIZATION

Recognizing the importance of planning, developing, and financing sewer system facilities to provide reliable and enhanced service for existing customers and to serve anticipated growth, the City initiated the preparation of this sewer system master planning study.

On December 4, 2000, The City authorized Carollo Engineers to prepare this sewer system master plan study which included the following tasks:

- Establish sewer system design and planning criteria.
- Review Infiltration and Inflow Flow Monitoring Data performed by another Consultant.
- Evaluate the capacity of the existing sewer collection system using computer hydraulic modeling.
- Summarize existing system deficiencies and propose improvements to enhance system reliability.
- Recommend improvements needed to service anticipated future growth.
- Develop a Capital Improvement Program with a planning horizon year of 2020.

Figure 1.1
REGIONAL LOCATION MAP
CITY OF MORGAN HILL
MASTER PLAN

The study includes several planning assumptions that are documented in this report. Should future planning conditions deviate from the assumptions stated in this master plan (i.e., accelerated growth, more intense developments, supply source modifications, etc.), revisions and adjustments to the master plan recommendations would be necessary.

1.3 REPORT ORGANIZATION

The sewer system master plan report contains seven chapters, followed by appendices that provide supporting documentation for the information presented in the report. The chapters are briefly described below:

Chapter 1 - Introduction. This chapter presents the need for this sewer system master plan and the objectives of the study. A list of abbreviations is also provided to assist the reader in understanding the information presented.

Chapter 2 - Planning Area Characteristics. This chapter presents a discussion of this study's planning area characteristics, defining the land use classifications and summarizing the historical population trends. Population projections, as used in this master plan, are based on the most recent General Plan and provide guidance for forecasting sewer flows and for staging future sewer system improvements.

Chapter 3 - Planning and Design Criteria. The capacity of the City's sanitary sewer system was evaluated based on the analysis and design criteria defined in this chapter. Historical flows at the wastewater treatment facility were reviewed and analyzed to determine daily, monthly and seasonal fluctuations experienced by the sewer system. The developed criteria address the sewer system capacity, acceptable pipe gravity slopes, acceptable depths of flow within pipes, average sewer flow coefficients, and daily and hourly peaking factors. Finally, potential infiltration and inflows are identified based on a recent flow monitoring program.

Chapter 4 - Existing System and Hydraulic Model. This chapter presents an overview of the City's sewer collection system. The chapter also describes the development and calibration of the City's Sewer Hydraulic Model. This model was used for identifying existing system deficiencies and for recommending enhancements.

Chapter 5 - Sewer System Evaluation and Proposed Improvements. This chapter presents the results of the capacity evaluation of the sewer system. The chapter also presents improvements to mitigate existing system deficiencies and for servicing future growth. These improvements are recommended based on the system's technical requirements, cost effectiveness, and operational reliability.

Chapter 6 - Capital Improvement Program. This chapter presents the recommended Capital Improvement Program (CIP) for the City of Morgan Hill sewer system. The program is based on the evaluation of the City's sewer system, and on the recommended projects described in the previous chapters. The CIP has been staged to the planning horizon year of 2020.

1.4 ACKNOWLEDGMENTS

Carollo Engineers wishes to acknowledge and thank Mr. Jim Ashcraft, Director of Public Works and City Engineer; Mrs. Alice Tulloch, Project Manager; Mr. Ray Dellanini, Utility Systems Manager; and Ms. Julie Behzad, Associate Engineer. Their own and their staff's cooperation and courtesy in obtaining a variety of necessary information were valuable components in completing and producing this report.

1.5 ABBREVIATIONS AND DEFINITIONS

To conserve space and to improve readability, the following abbreviations are used in this report.

ADWF	average dry weather flow
ASCE	American Society of Civil Engineers
BWF	base wastewater flow
CIP	capital improvement program
City	City of Morgan Hill
cfs	cubic feet per second
CMCA	Crawford Multari & Clark Associates
County	County of Santa Clara
DOF	Department of Finance
ENR CCI	Engineering News Records Construction Cost Index
fps	feet per second
GIS Master	AutoCAD “add-on” tool used to assemble hydraulic model
gpda	gallons per day per acre
gpdc	gallons per day per capita
GWI	groundwater infiltration
HYDRA	Computer Hydraulic Model developed by Pizer
I/I	infiltration/inflow
Joint Trunk	Joint Morgan Hill – Gilroy Sewer Trunk
LF	linear feet
MDWWF	maximum day wet weather flow
MGD	million gallons per day
PDWF	peak dry weather flow
PWWF	peak wet weather flow

RDI/I	rainfall dependent infiltration & inflow
ROW	right-of-way
R-Value	percentage of rainfall volume
SCRWA	South County Regional Wastewater Authority
SCVWD	Santa Clara Valley Water District
SOI	sphere of influence
UGB	Urban Growth Boundary
WEF	Water Environment Federation
WWTF	Wastewater Treatment Facility

PLANNING AREA CHARACTERISTICS

This chapter presents a discussion of this study's planning area characteristics, defining the land use classifications and summarizing the historical population trends. Population projections, as used in this master plan, are based on the most recent General Plan and provide guidance for forecasting sewer flows and for staging future sewer system improvements.

2.1 STUDY AREA

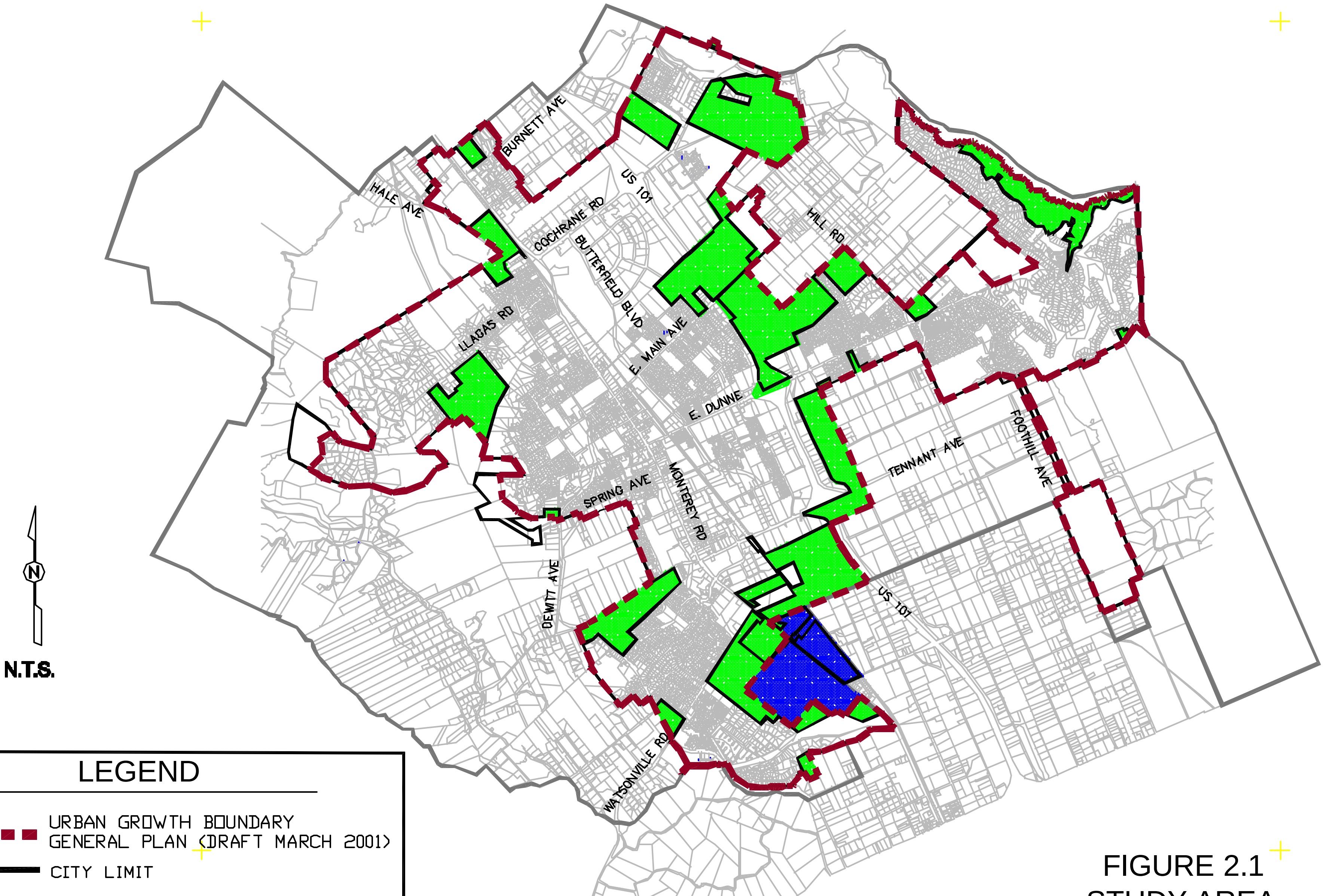
The City of Morgan Hill is located in Santa Clara County, approximately 12 miles south of the City of San Jose and 10 miles north of the City of Gilroy. The City is bisected by State Highway 101 in a north-south direction. In 1996, the City Council adopted a long-term Urban Growth Boundary (UGB), which identifies lands intended for future urbanization within the Sphere of Influence (SOI).

The 2001 Draft General Plan (March 2001) developed by Crawford Multari & Clark Associates identifies the boundaries of the UGB, as used in this study (Figure 2.1). The City's current General Plan, which was subsequently adopted in July 2001, includes an area in the southeast portion of the City that has been added to the draft version (March 2001) of the General Plan. Though not included in the planning study, this area is not anticipated to change the recommendations of this master plan. The City's water distribution, sewer collection, and storm drainage master plans were prepared concurrently and identified the infrastructure necessary to service developed lands within the UGB. According to the General Plan, areas outside the UGB are intended to remain rural and unincorporated for the next 20 years.

2.2 SOIL AND TOPOGRAPHY

The study area forms in the southern Santa Clara County and encompasses the eastern foothill slopes of the Santa Cruz Mountain range and the western foothill slopes of the Mt. Hamilton range, and the broad, flat alluvial plain between them. The majority of the land within the study area is flat, alluvial terrain. The level terrain is adjoined by rolling foothills and steeper slopes of the mountain ranges, both to the east and west. The dominant soil types are upland soils developed on sedimentary, basic igneous, and serpentine rock, the slow to very slow draining subsoils of alluvial fans, and the moderately well to rapid draining medium to fine textured soils of the alluvial plain. Soil cover and vegetation in the area includes a wide range of trees, thick brush, and grass.

Most of the City is on relatively flat valley land, with some developments on the foothill areas both east and west of the valley floor. Elevations range from approximately 350 feet on the valley floor to over 1,200 feet in the foothills.



LEGEND

- URBAN GROWTH BOUNDARY GENERAL PLAN (DRAFT MARCH 2001)
- CITY LIMIT
- SPHERE OF INFLUENCE
- EXPANSION AREAS
- AREA ADDED TO GENERAL PLAN (ADOPTED JULY 2001)

FIGURE 2.1
STUDY AREA
CITY OF MORGAN HILL
MASTER PLAN

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Geologically, the City of Morgan Hill is situated on the drainage divide between the San Francisco Bay and Monterey Bay. The majority of the valley floor slopes down southward and drains into the Pajaro River and Monterey Bay. A portion of the valley floor slopes down northward and drains into Fisher and Coyote Creek, thence to San Francisco Bay

Flood control for the City's creeks and control of the two local groundwater basins are under the jurisdiction of the Santa Clara Valley Water District (SCVWD). The majority of the City is located over the Llagas groundwater basin with the Coyote groundwater basin situated just to the north of the City. SCVWD also owns and operates several reservoirs and water recharge facilities within the watersheds tributary to the City.

2.3 LAND USE

The land use classifications used in this master plan are consistent with the Land Use Element of the City's General Plan Update, and as later updated on a map provided by Crawford Multari & Clark Associates, dated March 2001 (Figure 2.2). The land use designations are summarized in Table 2.1, along with residential densities, current vacant lands, and planned annexations within the next 20 years.

Residential Estate (RE). This designation is intended to promote family living on large parcels of land. Concentrated along the western and southern City limits, The maximum density of this land use designation is one dwelling unit per acre.

Single Family Low (SFL). This designation is intended to accommodate single family homes on medium-sized parcels. The highest concentrations of this category are the eastern City limits, especially near Anderson Reservoir. The maximum acceptable density for new developments is three dwelling units per acre.

Single Family Medium (SFM). This designation is dispersed throughout the City providing a transition from non-residential areas to lower density neighborhoods. The maximum acceptable density of this designation is five dwelling units per acre.

Multi-Family Low (MFL). This designation is intended to accommodate both attached and detached residential dwelling units with a maximum acceptable density of 15 dwelling units per acre.

Multi-Family Medium (MFM). This highest density residential designation consists mainly of attached apartments and condominiums, and allows a maximum of 21 dwelling units per acre.

Retail Commercial and Non-Retail Commercial (COM). The retail commercial designation is intended for retail business, office uses, and professional services. The Non-Retail Commercial promotes service and office spaces away from major intersections. It also accommodates mixed use developments (residences above shops). For the purpose of this master plan, these two designations are combined.

General Commercial (GCOM). This designation allows a variety of commercial uses.

Mixed Use (MIX). This designation is intended to encourage a mixture of retail uses and residences.

Industrial (IND). This designation is intended for a variety of existing and potential research, warehouse, manufacturing, service commercial, and other uses.

Office Industrial (OIND). This designation is intended to promote administrative and executive office uses.

Campus Industrial (CIND). This designation is intended to promote high technology and medical services in park-like setting that contain large areas of landscaping.

Public Facilities (PUB). This designation is comprised of lands used by the City, service providers (including emergency medical, hospitals, and utility companies), and the Morgan Hill Unified School District.

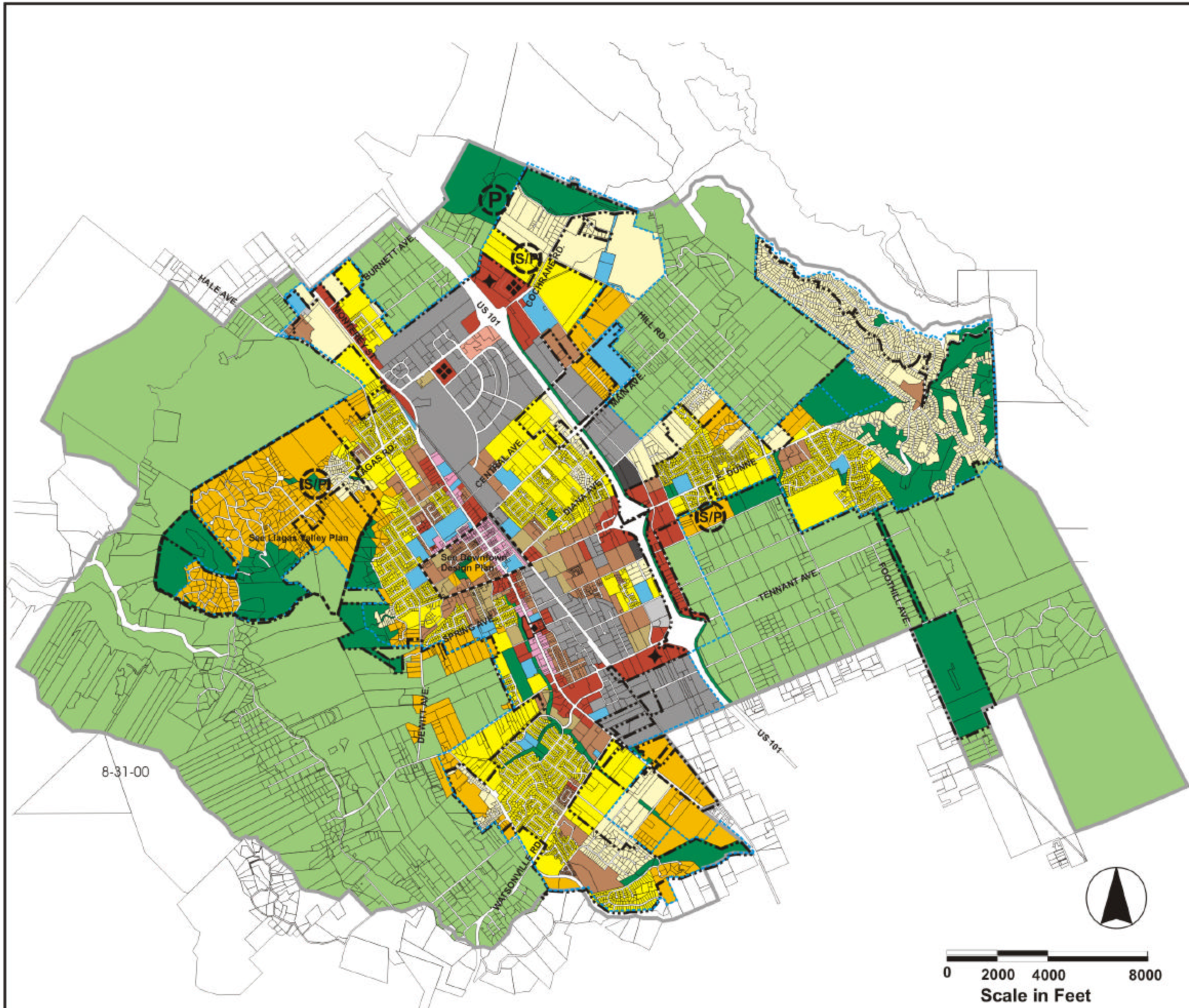
Rural County (RC). This designation applies to over 8,000 acres outside the current City limits in the Sphere of Influence. Lots with Rural County designation generally are 5-20 acres with one single family home or agricultural operation. The maximum density of the Rural County designation is generally one dwelling unit per 5 acres.

Open Space (OS). Public parks and private golf courses account for most of the acreage's of Open Space designation in the City and Sphere of Influence. Measure P dictates that land in the City that was designated Open Space as of 1990 shall remain so through year 2010.

Table 2.1 - Land Use and Vacant Areas
Water System Master Plan
City of Morgan Hill

Land Use Designations	Coded Desig.	Density Range (DU/gr. Ac.)	Existing Condition Within City Limits[1] 2001 Developed (net Ac.)[3]	2001 Vacant (net Ac.)[3]	2001 Total (net Ac.)[3]	Future Condition: Buildout Within Urban Growth Boundary 2001 Developed (net Ac.)[3]	2001 Vacant (net Ac.)[3]	UGB Total (net Ac.)[3]	Future Condition: Buildout Within Sphere of Influence[1,4] SOI Developed (net Ac.)[3]	SOI Vacant (net Ac.)[3]	SOI Total (net Ac.)[3]
Residential Land Uses											
Residential Estate	RE	< 1	513	356	869	609	474	1,083	751	465	1,216
Single Family Low	SFL	1 - 3	597	109	706	753	391	1,144	776	503	1,279
Single Family Medium	SFM	3 - 5	1,083	402	1,485	1,108	626	1,734	1,110	691	1,801
Multi-Family Low	MFL	5 - 14	302	160	462	314	179	493	310	221	531
Multi-Family Medium	MFM	14 - 21	98	69	167	94	68	162	98	73	171
Subtotal			2,593	1,096	3,689	2,878	1,738	4,616	3,045	1,953	4,998
Non-Residential Land Uses											
Commercial (retail)	COM		272	273	545	282	298	580	282	172	454
General Commercial	GCOM		23	1	24	22	1	23	23	1	24
Industrial	IND		382	318	700	388	337	725	392	720	1,112
Office Industrial	OIND		0	21	21	0	21	21	0	26	26
Campus Industrial	CIND		2	18	20	4	101	105	4	14	18
Mixed Use	MIX		42	3	45	42	3	45	42	8	50
Subtotal			721	634	1,355	738	761	1,499	743	941	1,684
Other Land Uses											
Open Space	OS		151	979	1,130	154	851	1,005	296	2,197	2,493
Public Facilites	PUB		45	172	217	47	191	238	50	203	253
Rural County (Outside SOI)	RC		6	76	82	119	329	448	2,680	5,383	8,063
Subtotal			202	1,227	1,429	320	1,371	1,691	3,026	7,783	10,809
Total			**3,516**	2,957	6,473	3,936	3,870	**7,806**	6,814	10,677	17,491

Notes:
1. Source: City of Morgan Hill General Plan Update: Crawford Multari & Clark Associates. March 2001.
2. All acreages were extracted from the Parcels database and exclude street ROW.
3. General Plan acreages were based on the Parcels database, and are therefore considered net acres.
4. The Rural County Designation Includes lands within the City's Sphere of Influence but which may be outside the urban growth boundary.



City of Morgan Hill

2020 General Plan

Rural County	
Open Space	
Residential Estate	0-1 du/ac
Single Family Low	1-3 du/ac
Single Family Medium	3-5 du/ac
Multi-Family Low	5-14 du/ac
Multi-Family Medium	14-21 du/ac
Commercial	
General Commercial* (See Action CD-9.3)	
Non-Retail Commercial	
Industrial	
Office Industrial	
Campus Industrial	
Public Facilities	
(P) Park (general location where needed)	
(S) School (general location where needed)	
❖ Grocery Store Site (See Action CD-9.6)	
✦ Sub-Regional Commercial Site (See Action CD-10.1)	
Master Plan Area (See Action CD-12.4)	

Boundaries

- Parcel
- City Limit
- Sphere of Influence
- Urban Growth Boundary
- Sub Area Plans

FIGURE 2.2
LAND USE DESIGNATIONS

Source: City of Morgan Hill; Crawford Multari & Clark

2.4 HISTORICAL AND FUTURE GROWTH

The City was incorporated in 1906 as primarily an agricultural settlement serving farms and ranches. As the City was transformed into a primarily suburban residential community in the 1960's, two growth control measures passed in the 1980's resulted in a reduced growth rate. From 1970 to 1980, population has increased from approximately 5,600 to 16,800, an average annual growth rate of 11.5 percent over the 10-year period. From 1980 to 2000, population has grown from 16,800 to 33,000, with an average annual growth rate of 3.5 percent over the 20-year period. During this period, the annual population growth has ranged between a low of 1.1 percent in 1983 to a high of 6.3 percent in 1989.

The Morgan Hill General Plan Update (Draft dated March 2001), assumes that the current residential growth control will remain through the planning horizon year of 2020, yielding an average annual growth rate over the next 20 years of 1.8 percent. The General Plan Update further projects population ceilings of 38,800 and 48,000 for the years 2010 and 2020, respectively (Table 2.2). Year 2020 also coincides with the planning horizon for these master plans.

The General Plan Update stipulates consistency with the California Department of Finance (DOF) for determining occupancy levels per dwelling units. The DOF indicates that housing information from the 2000 Census will be available in the early part of 2002, and that as of January 1, 1999, the household size in the City of Morgan Hill was 3.19 (people per dwelling units). For master planning purposes, a household size of 3.2 will be used.

Table 2.2 Historical and Projected Population
Water System Master Plan
City of Morgan Hill

Year	Population[1,2,3]	Annual Growth (%)	Historical and Projected Growth		
1980	16,800				
1981	17,600	4.8%			
1982	18,050	2.6%			
1983	18,250	1.1%			
1984	18,550	1.6%			
1985	19,200	3.5%		1980-1990 10-year Average 3.6%	
1986	19,950	3.9%			
1987	20,500	2.8%			
1988	21,400	4.4%			
1989	22,750	6.3%			
1990	23,950	5.3%			Historical 20-year Average 3.5%
1991	24,800	3.5%			
1992	25,100	1.2%			
1993	25,650	2.2%			
1994	26,200	2.1%			
1995	26,900	2.7%		1990-2000 10-year Average 3.3%	
1996	28,100	4.5%			
1997	29,250	4.1%	1995-2000 5-year Average 4.2%		
1998	30,700	5.0%			
1999	31,900	3.9%			
2000	**33,092**	3.7%			
2001	33,700	2.0%			
2002	34,400	2.0%	5-year Average 2.0%		
2003	35,100	2.0%			
2004	35,800	2.0%			
2005	**36,500**	2.0%			
2006	36,900	1.2%			
2007	37,300	1.2%	5-year Average 1.2%		
2008	37,800	1.2%			
2009	38,300	1.2%			
2010	**38,800**	1.2%			2001 General Plan Update 20-year Average 1.87%
2011	39,700	2.3%			
2012	40,600	2.3%	5-year Average 2.3%		
2013	41,500	2.3%			
2014	42,400	2.3%			
2015	**43,400**	2.3%			
2016	44,300	2.1%			
2017	45,200	2.1%	5-year Average 2.1%		
2018	46,100	2.1%			
2019	47,000	2.1%			
2020	**48,000**	2.1%			

Notes:
1. Historical Population Source: California Department of Finance.
2. US Census Bureau lists Historical Population for Morgan Hill of 17,060 in 1980 population, 23,928 in 1990, and 33,556 in 2000
3. Population Projections Source: City of Morgan Hill General Plan Update (Draft March 2001, and Adopted July 2001) prepared by Crawford Multari & Clark Associates.

PLANNING AND DESIGN CRITERIA

The capacity of the City's sanitary sewer system was evaluated based on the analysis and design criteria defined in this chapter. Historical flows at the wastewater treatment facility were reviewed and analyzed to determine daily, monthly and seasonal fluctuations experienced by the sewer system. The developed criteria address the sewer system capacity, acceptable pipe gravity slopes, acceptable depths of flow within pipes, average sewer flow coefficients, and daily and hourly peaking factors. Finally, potential infiltration and inflows are identified based on a recent flow monitoring program.

3.1 GRAVITY SEWERS

Capacity analysis of the gravity sewers was performed in accordance with the criteria established in this section.

3.1.1 Pipe Capacities

Sewer pipe capacities are dependent on many factors. These include roughness of the pipe, the chosen maximum allowable depth of flow, and limiting velocity and slope. The Continuity equation and the Manning equation for steady-state flow are used for gravity sewer hydraulic calculations:

Continuity Equation: $Q = VA$

Where: Q = peak flow, cfs
V = velocity, fps
A = cross-sectional area of pipe, sq. ft.

Manning Equation: $V = (1.486 R^{2/3} S^{1/2})/n$

Where: V = velocity, fps
n = Manning's coefficient of friction
R = hydraulic radius (area divided by wetted perimeter), ft
S = slope of pipe, feet per foot

3.1.2 Manning Coefficient (n)

The Manning coefficient 'n' is a friction coefficient and varies with respect to pipe material, size of pipe, depth of flow, smoothness of joints, root intrusion, and other factors. For sewer pipes, the Manning Coefficient typically ranges between 0.011 and 0.017, with 0.013 being a representative value used for system master planning purposes.

3.1.3 Flow Depth Criteria (d/D)

When designing sewer pipelines, it is common practice to adopt variable flow depth criteria for various pipe sizes. This criteria is expressed as a maximum depth of flow to pipe diameter ratio (d/D). Design d/D ratios typically range from 0.5 to 1.0, with the lower values typically used for smaller pipes - which may experience flow peaks greater than planned or may experience blockages from debris, paper, or rags. It is recommended that a design d/D ratio of 0.75 be used for designing new gravity sewer pipes in the City of Morgan Hill.

The design flow criteria established for the City's existing sewer system hydraulic model already provide sufficient degree of conservatism, and utilizing a d/D ratio of 0.75 for analysis purposes may lead to premature or unnecessary replacement of existing pipelines. Therefore, a d/D ratio of 0.9 will be utilized to evaluate Morgan Hill's existing trunk system, while a d/D ratio of 0.75 will be utilized for designing the future trunk system. Furthermore, when evaluating the pipe capacities during peak wet weather flows, pipes were allowed to surcharge and the hydraulic grade line allowed to rise up to one foot below the manhole rims.

In order to minimize the settlement of sewage solids, it is standard practice in the design of gravity sewers to specify that a minimum velocity of 2 feet per second (fps) be maintained when the pipeline is half-full. At this velocity, the sewer flow will typically provide self-cleaning for the pipe. Due to hydraulics of a circular conduit, velocity of half-full flow in pipes approaches the velocity of nearly full flow in pipes. Table 3.1 lists the minimum slopes for maintaining self-cleaning full flow velocities. It does not list slopes less than 0.0008, which is the minimum practical slope for gravity sewer in construction. It should be noted that greater slopes are desirable if they are compatible with existing topography, though not to exceed a velocity of 10 fps.

3.1.4 Changes in Pipe Size

When a smaller sewer joins a large one, the invert of the larger sewer will be lowered sufficiently to maintain the same energy gradient. An approximate method for securing these results is to place the 0.8 depth point of both sewers at the same elevation. For master planning purposes, and in the absence of field data, sewer crowns will be matched at the manholes.

3.2 PUMP STATIONS AND FORCE MAINS

Pump stations will be evaluated and designed for peak flow with one standby pump having a capacity equal to the largest operating unit. For the design of force mains, the minimum and maximum recommended velocities are 2.0 and 6.5 fps, respectively. The Hazen-Williams formula is commonly used for the design of force mains. The velocity equation is:

$$V = 1.32\ C\ R\ 0.63\ S\ 0.54$$

Where: V = mean velocity, fps
C = roughness coefficient
R = hydraulic radius, ft
S = slope of the energy grade line, ft/ft

Table 3.1 Minimum Slopes for New Circular Pipes
Sewer System Master Plan
City of Morgan Hill

Pipe Size (in.)	d/D = 0.50			d/D = 0.75		
	Preferred Slope [2] (ft/ft)	Pipe Capacity (mgd)	Pipe Capacity (cfs)	Minimum Slope [3] (ft/ft)	Pipe Capacity (mgd)	Pipe Capacity (cfs)
6	0.0049	0.13	0.20	0.0038	0.20	0.31
8	0.0033	0.22	0.35	0.0026	0.36	0.55
10	0.0025	0.35	0.55	0.0019	0.56	0.87
12	0.0019	0.50	0.78	0.0015	0.79	1.23
15	0.0015	0.81	1.25	0.0011	1.28	1.98
18	0.0011	1.13	1.74	0.0009	1.78	2.75
21	0.0009	1.54	2.38	0.0007	2.43	3.76
24	0.0008	2.07	3.20	0.0006	3.27	5.05
27	0.0007	2.65	4.10	0.0005	4.18	6.47
30	0.0006	3.25	5.02	0.0004	5.13	7.94
33	0.0005	3.82	5.91	0.0004	6.04	9.34
36	0.0005	4.82	7.46	0.0003	7.61	11.78
42	0.0004	6.50	10.06	0.0003	10.27	15.90

Notes:
1. Slopes were calculated using Manning's formula for pipes flowing 1/2 full and 3/4 full, with a mimum velocity of 2 fps
2. Preferred slopes are desirable for maintaining self cleaning velocities of 2 fps, when the pipe is half-full.
3. Minimum slopes are calculated based on maintinaing velocities of 2 fps when pipes are 3/4 full.
4. Approval by the City Engineer is required if:
   a. Designed slopes are flatter than the Minimum Slopes
   b. Designed slopes are flatter than the practical slope of 0.0008

The value of the Hazen-Williams 'C' varies with the type of pipe material and is influenced by the type of construction and age of the pipe. A 'C' value of 120 will be used for this Master Plan.

3.3 WASTEWATER DESIGN FLOWS

Historical flows at the wastewater treatment facility were reviewed and analyzed to determine daily, monthly and seasonal fluctuations experienced by the sewer system. The design flow criteria included developing peaking factors for estimating Peak Dry Weather Flows (PDWF). A flow monitoring program, recently completed by another consultant, was also used to identify the wet weather flows components. Finally, the Average Dry Weather Flow (ADWF) coefficients, were developed for each land use category.

3.3.1 Wastewater Treatment Facility Flows

The initial step in establishing the wastewater flow criteria for the City included a review of historical flow data influent to the Wastewater Treatment Facility (WWTF) in Gilroy collected for the past three years. Monthly historical flows at the Gilroy WWTF influent line, between January and December 2000, were obtained from the monthly monitoring program records, and are summarized in Table 3.2.

The table lists, for each month, the minimum day flow (lowest flow recorded during any single day of the month), the average day flow for each month, the maximum day flow (highest flow recorded during any single day of the month), and the peak hour flow (highest hour flow). Maximum day peaking factors were calculated by dividing the maximum day flows by the average flow for that year. Similarly, peak hour factors were calculated by dividing the peak hour flows by the average flow for that year.

3.3.2 Wastewater Flow Components

Daily flows from the City for the year 2000, and the corresponding rainfall events and intensities were obtained from City records and are summarized in Figure 3.1. The figure clearly indicates higher sewer flows experienced during the wet weather season, and pronounced peaks corresponding to rainfall events.

The City’s wastewater flows consist of many components including the base wastewater flow (BWF), plus extraneous groundwater and storm water, termed infiltration/inflow (I/I), that may enter the sewers through pipe and manhole defects or direct drainage connections. I/I flows are dependent upon groundwater levels and rainfall patterns. Peak I/I flows occur during major rainstorms and are related to the intensity and duration of rainfall.

Table 3.2 Historical Monthly Sewer Inflows at WWTF

Sewer System Master Plan
City of Morgan Hill

Year 2000	Minimum Day (mgd)	Average Day (mgd)	Maximum Day (mgd)	MaxDay / AvgDay Factor
January	2.69	3.09	5.19	1.76
February	2.90	3.59	5.00	1.70
March	3.01	3.38	3.92	1.33
April	2.91	3.03	3.22	1.09
May	2.68	2.81	2.99	1.01
June	2.38	2.55	2.75	0.93
July	2.56	2.70	2.81	0.95
August	2.54	2.75	2.92	0.99
September	2.61	2.77	3.02	1.02
October	2.70	2.80	3.04	1.03
November	2.71	2.90	3.06	1.04
December	2.73	3.01	3.19	1.08

Year 2000 Monthly Summaries

Year	Average Day (mgd)	Wet Max Month (mgd)	Dry Max Month (mgd)	Wet Max Month Factor	Dry Max Month Factor
2000	2.9	3.59	2.81	1.22	0.95

Year 2000 Daily Summary

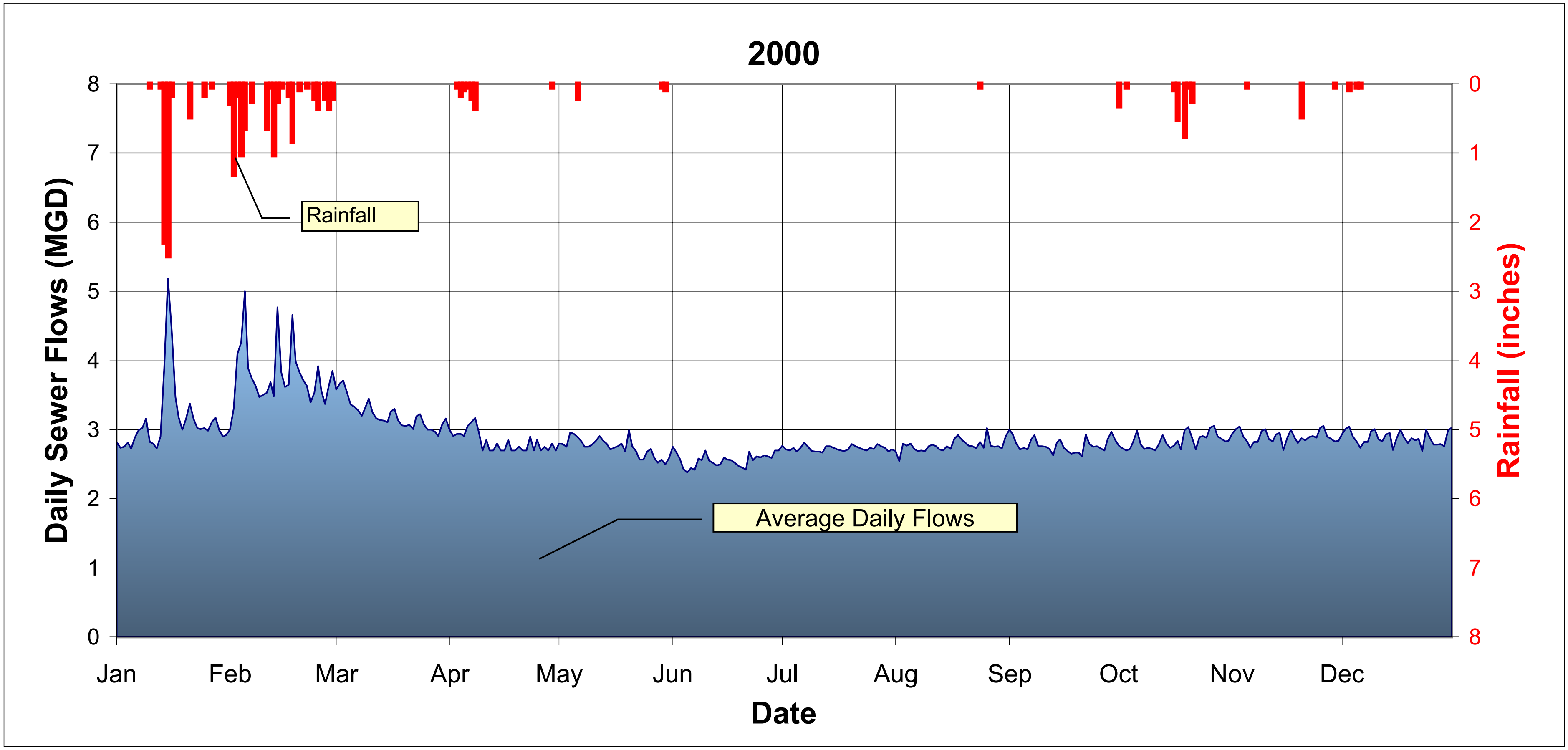
Year	Average Day (mgd)	Wet Max Day (mgd)	Dry Max Day (mgd)	Wet Max Day Factor	Dry Max Day Factor
2000	2.9	5.19	3.04	1.76	1.03

Year 2000 Hourly Summary

Year	Average Day (mgd)	Wet Peak Hour (mgd)	Dry Peak Hour (mgd)	Wet Peak Hour Factor	Dry Peak Hour Factor
2000	2.9	6.80	-	2.31	-

Source: City of Gilroy Wastewater Treatment Facility, Monthly Monitoring Program (See Appendix C)

Figure 3.1 Daily Sewer Flows and Rainfall (2000)
Sewer System Master Plan
City of Morgan Hill



3.3.3 Base Wastewater Flow

The base wastewater flow (BWF) is the flow generated by the City's residential, commercial, and industrial customers. The flow has a diurnal pattern that varies with land use categories. Typically, a residential diurnal has a two-peak pattern with the more pronounced peak following the wake-up hours of the day, and a less pronounced peak occurring in the evening. Commercial and industrial patterns, though they vary depending on the type of use, typically have more consistent higher flow patterns during business hours, and lower flows at night. Furthermore, the diurnal flow pattern experienced during a weekend may vary from the diurnal flow experienced during a weekday. Figure 3.2 illustrates a slight difference between these two diurnal patterns. For the purpose of hydraulically evaluating the collection system, the more pronounced curve will be used.

3.3.4 Groundwater Infiltration

Groundwater Infiltration (GWI), one of the components of I/I, is associated with extraneous water entering the sewer system through defects in pipes and manholes. This component is related to the condition of the sewer pipes, manholes, and groundwater levels. Groundwater infiltration may occur throughout the year, although groundwater infiltration rates are typically higher in the late winter and early spring. Dry weather groundwater infiltration (or base infiltration) cannot easily be separated from BWF by flow measurement techniques.

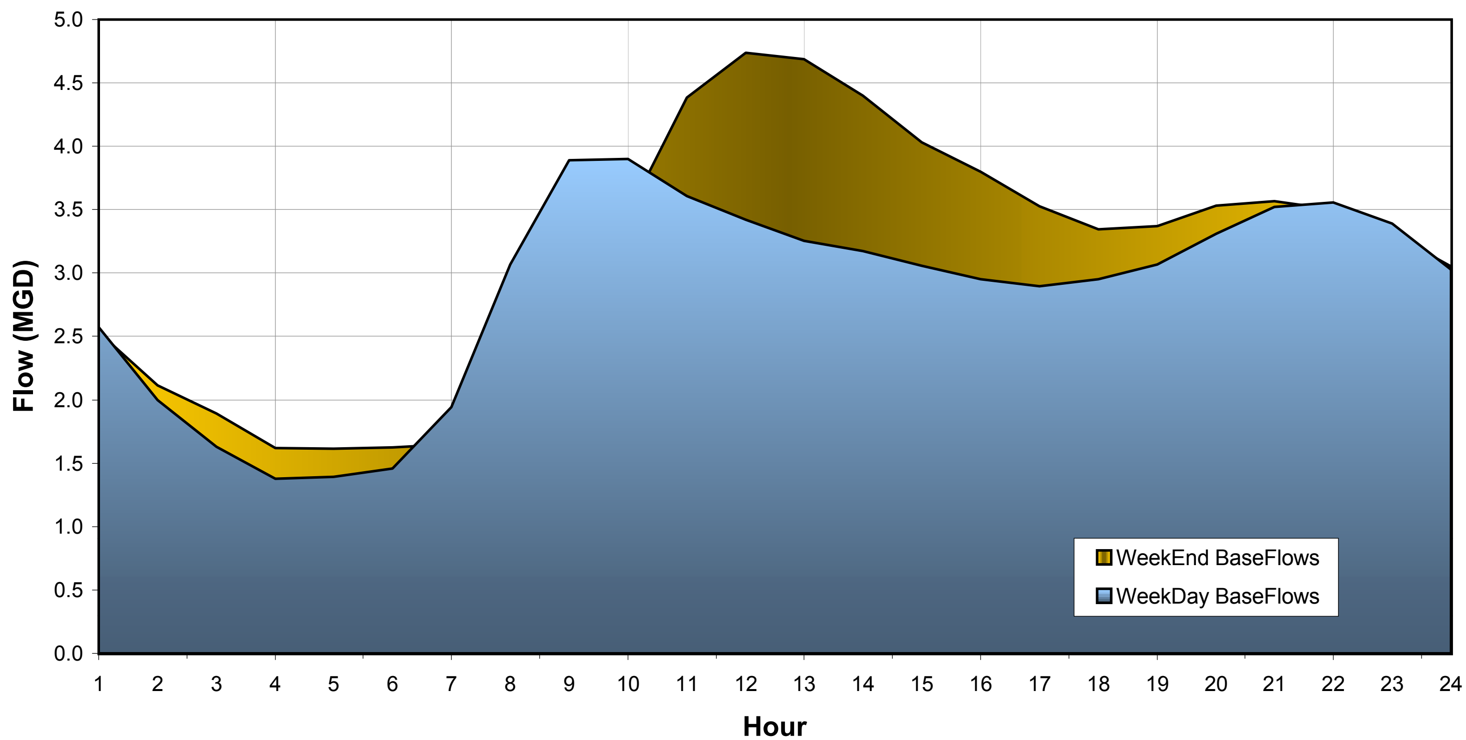
3.3.5 Average Dry Weather Flow

The average dry weather flow (ADWF) is the average flow that occurs on a daily basis during the dry weather season, with no evident reaction to rainfall. The ADWF includes the BWF generated by the City's residential, commercial, and industrial users, plus the dry weather GWI component. The importance of this component lies in its use as a basis for expressing other flow components by applying multipliers to the ADWF. In 2000, the City's dry weather flow was 2.9 MGD.

3.3.6 Peak Dry Weather Flow

The peak dry weather flow (PDWF) is the highest observed hourly flow that occurs during the dry weather season. The peak dry weather flow component is typically used for designing the capacity of sewer pipes, and it was used in this analysis to evaluate the sewer system. The hydraulic analysis disallowed surcharging during dry weather conditions, and flows exceeding the capacity of the sewer pipe during dry weather flows were considered causing a deficiency. In 2000, the City's peak dry weather flow was 4.2 MGD.

Figure 3.2 Dry Weather Diurnal Flow Patterns
Sewer System Master Plan
City of Morgan Hill



3.3.7 Maximum Day Wet Weather Flows

The maximum day wet weather flow (MDWWF) is the highest daily flow that occurs during the wet weather. The Water Environment Federation (WEF) Manual of Practice FD-6 and the American Society of Civil Engineers (ASCE) Manual and Report on Engineering Practice No. 62 suggest that the MDWWF to ADWF ratio typically ranges between 2 and 3, even in well-constructed systems. Higher values usually indicate a more pronounced I/I problem. In 2000, the City's maximum day wet weather flow was 3.0 MGD and the MDWWF to ADWF ratio was 1.76 (Table 3.2).

3.3.8 Peak Wet Weather Flow

The peak wet weather flow (PWWF) is the highest observed hourly flow that occurs during the wet weather season. The peak wet weather flow component is typically used for designing the capacity of the sewer system while providing some acceptable allowance for surcharging. Unlike the peak dry weather flow analysis, the hydraulic analysis allowed surcharging during wet weather conditions with the hydraulic grade line rising up to a foot below the manhole rim. Flows that exceeded that level were considered causing a deficiency. In 2000, the City's peak wet weather flow was 6.8 MGD.

The WEF Manual of Practice FD-6 and ASCE Manual No. 62 suggest typical wet peak to dry average ratios ranging between 3 and 4, with higher values indicative of pronounced infiltration and inflows. In Morgan Hill, this City-wide ratio is 1.6, though flow monitoring indicates that some portions of the sewer system may have higher ratios.

3.3.9 Inflow and Infiltration

Inflow is a sharp rise in flow in direct response to a rainfall event. Infiltration is a slower response to the rainfall event, which builds up with time and continues even after rainfall has stopped. Rainfall Dependent Infiltration and Inflow (RDI/I) is typically estimated by reviewing and examining flow components, and by conducting temporary or long term flow monitoring programs. There are several methods for quantifying the I/I flows in the City's sewer system, and the "percentage of rainfall volume" (R-Value) methodology was used in this study. In this methodology, the R-Value is defined as the ratio between the volume of wet weather flow at a particular monitoring site and the rainfall volume that falls on the upstream tributary service area. The R-Values, expressed in percent and calculated for each storm event, are discussed in the following section.

3.3.10 Temporary Flow Monitoring Program

A temporary flow monitoring program was conducted to assist in the development of the design flow criteria. The primary purpose of the program was to determine the magnitude of the rain-dependent infiltration and inflow (RDI/I) into the City's sanitary sewer system. The temporary program, which was started in January 2001, consisted of installing 12 flow meters for a period of 90 days, at locations selected by City staff (Figure 3.3).

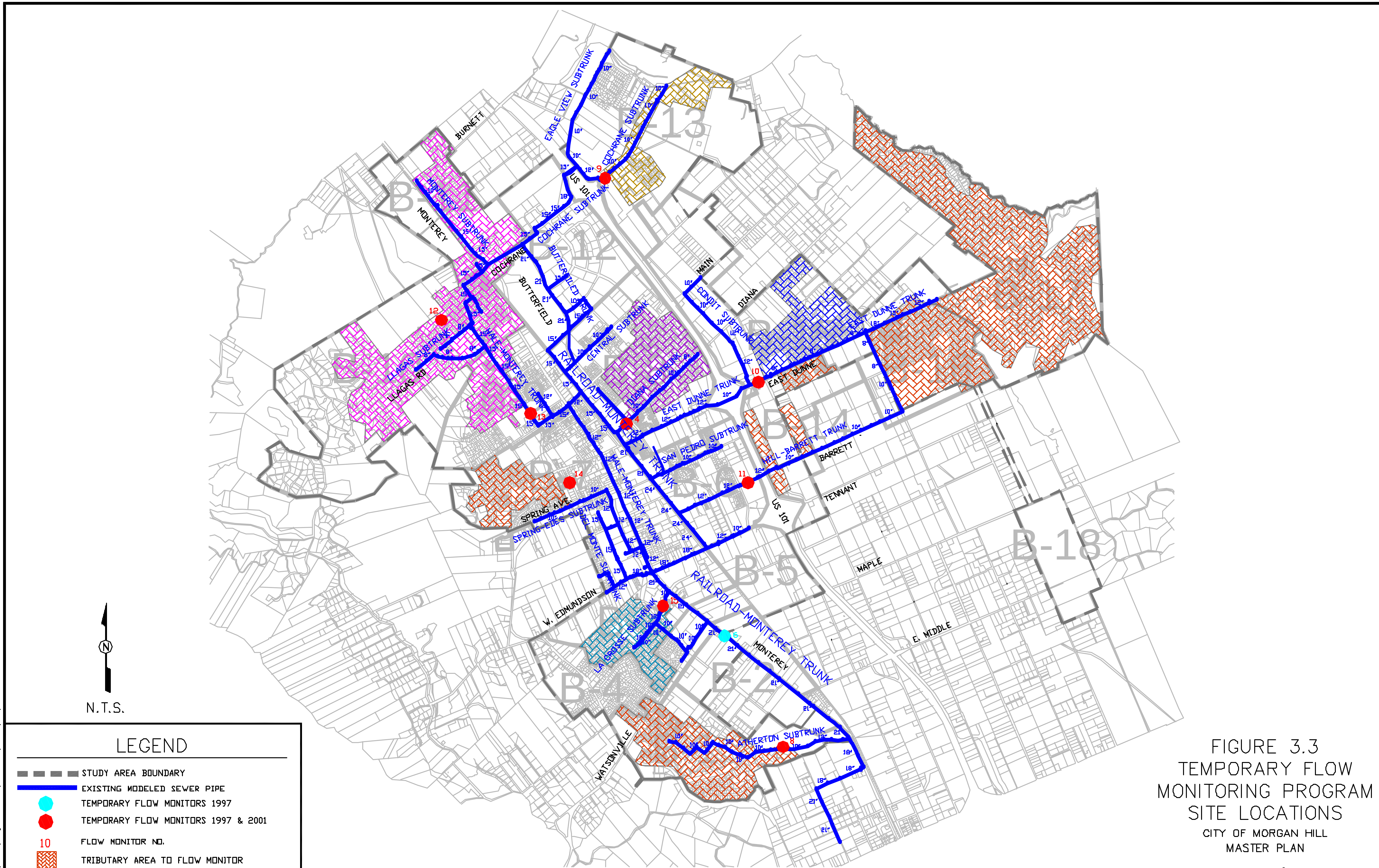


FIGURE 3.3
TEMPORARY FLOW
MONITORING PROGRAM
SITE LOCATIONS
CITY OF MORGAN HILL
MASTER PLAN

carollo engineers

H:\Client\MorganHill_FNO\8179A.00\Sewer\TempFlowMon1125 XREFS: UGB, SEWER PIPE, STREETS

The flow monitoring program results are summarized in detail in a report titled Wet Weather Flow Monitoring and Analysis (May 2001), prepared by V&A Consulting Engineers (Appendix B). Flow monitoring data extracted from said report were graphically plotted on Figure 3.4 which also shows the recorded rainfall events and their magnitude. The figure indicates that four distinct wet weather events occurred during the monitoring period.

The data further indicates that monitoring sites 4, 9, 10, 12, and 15 did not show definitive flow increases that could be directly attributed to the wet weather events. Monitoring sites 8, 11, 13, and 14 showed an increase in flow during wet weather events and their calculated R-Values are listed in Table 3.3.

Table 3.3 Temporary Flow Monitoring R-Values
Sewer System Master Plan
City of Morgan Hill

Event No.	Date	Site 8	Site 11	Site 13	Site 14
1	01/08/01	0.20%	0.90%	0.60%	0.70%
2	01/23/01	N/A	N/A	0.40%	1.20%
3	02/09/01	1.00%	0.40%	1.70%	2.10%
4	02/17/01	0.90%	2.90%	2.40%	2.30%

The rainfall experienced during the flow monitoring period is considered average, and the capacity evaluation of the system during wet weather events was performed to account for a hypothetical 5-year 24-hour design storm. Figure 3.5 provides a graphical comparison between the 2001 storm events and the design storm used in evaluating the City's sewer system.

3.3.11 Average Sewer Flow Coefficients

The average sewer flow coefficients are factors, usually expressed in gallons per day per acre (gpda), applied to either gross or net acres for calculating average dry weather flows (ADWF) generated from a particular land use designation. Average sewer flow coefficients for commercial and industrial areas may range from 500 to 2,500 gpda, with typical values averaging at approximately 1,000 gpda. Land uses designated as open space or agricultural are assumed to generate negligible amounts of sewage flow.

The City’s current design criteria dictates calculating average residential flows on a per capita basis using a minimum of 90 gallons per day per capita. Commercial and light industrial designations shall be computed at 1,500 gallons per gross acre per day, and industrial designations shall be computed using 2,500 gallons per gross acre per day.

Figure 3.4 Flow Monitoring Data
Sewer System Master Plan
City of Morgan Hill

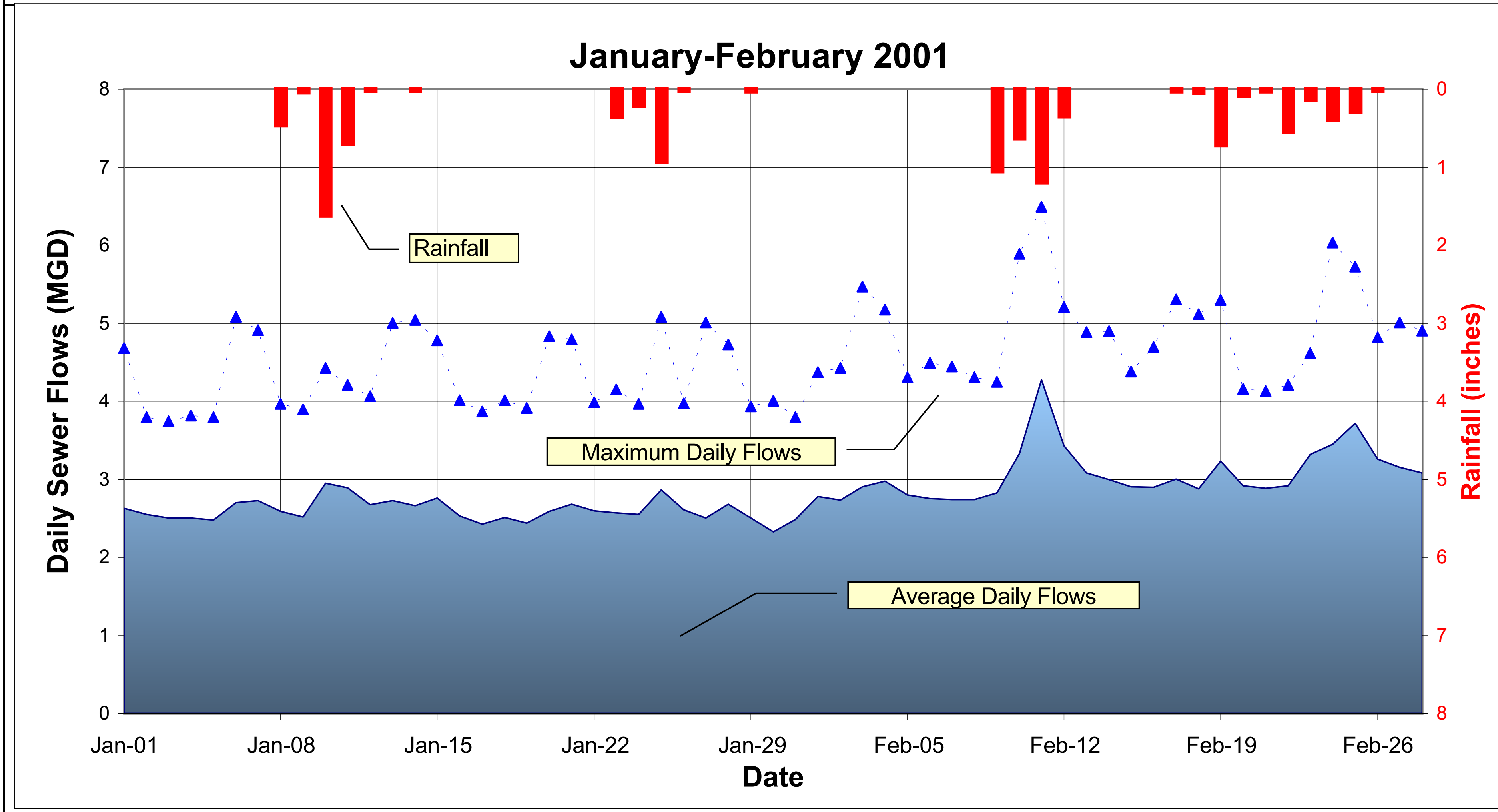


Figure 3.5 Design Storm vs. 2001 Rainfall Events
Sewer System Master Plan
City of Morgan Hill

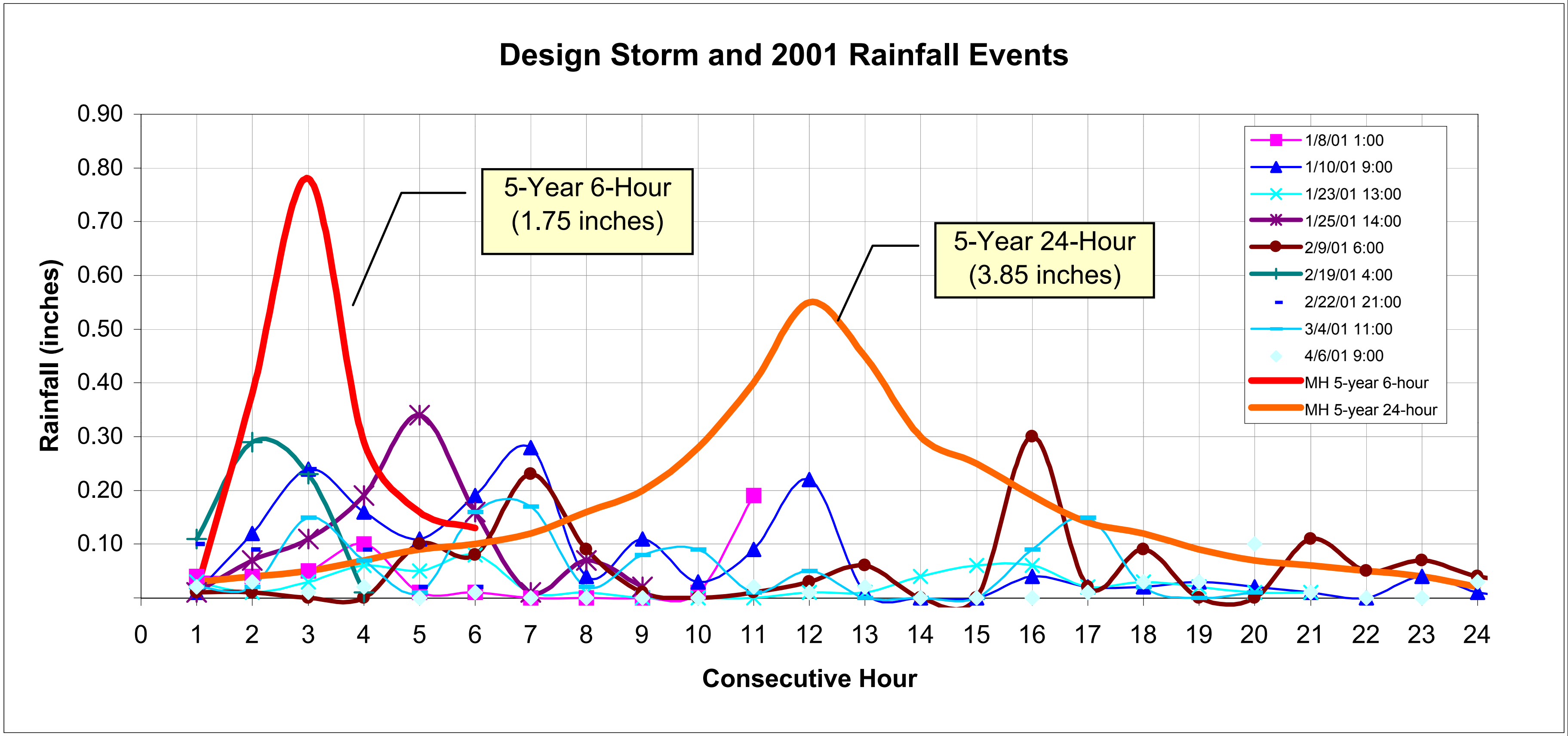


Table 3.4 presents the methodology for developing the average sewer flow coefficients for the City's land use designations. Since using the City's current criteria results with higher average flows, the flow coefficients were adjusted for performing the sewer flow balance.

The purpose for developing these lower coefficients was to ensure a sewer flow balance that mimics the actual existing flow conditions in the hydraulic model, and to avoid recommending premature construction of relief or replacement of existing sewer facilities

3.3.12 Dry Weather Peaking Factors

Peaking factors represent the increase in sewer flows experienced above the ADWF. The various peaking conditions are statistical concepts or numerical values obtained from a review of historical data and, at times, tempered by engineering judgement.

As previously discussed in this chapter, the peaking conditions that are of particular significance to hydraulic analysis of the sewer system include the peak dry weather flows (PDWF), and the peak wet weather flows (PWWF). Typically, peaking factors of 2.0 are used to estimate peak flows at treatment facilities, and peaking factors ranging between 3.0 and 4.0 are used to estimate peak flows in the smaller upstream areas of the system. The City of Morgan Hill has consistently used a table for calculating the dry weather flows. The table was published in the previous master plan and was provided to local engineers and developers for computing peak flows and designing new sewer systems.

This study has developed a peaking equation that reproduces the same results as the previously used look-up table and is consistent with City design standards. The developed equation is summarized below and graphically plotted on Figure 3.6.

$$Q_{peak} = XQ_{avg}^{\ 0.90}$$

Where,
Q_{peak} is the peak flow
Q_{avg} is the average flow
X is the peaking coefficient
X= 2.48 when cfs units are used
X= 2.37 when MGD units are used

In order to reflect higher instantaneous peaks experienced in the smaller upstream sewer pipes, the peaking factor curve decreases exponentially as the cumulative ADWF increase.

Table 3.4 Average Sewer Flow Coefficients

Sewer System Master Plan

City of Morgan Hill

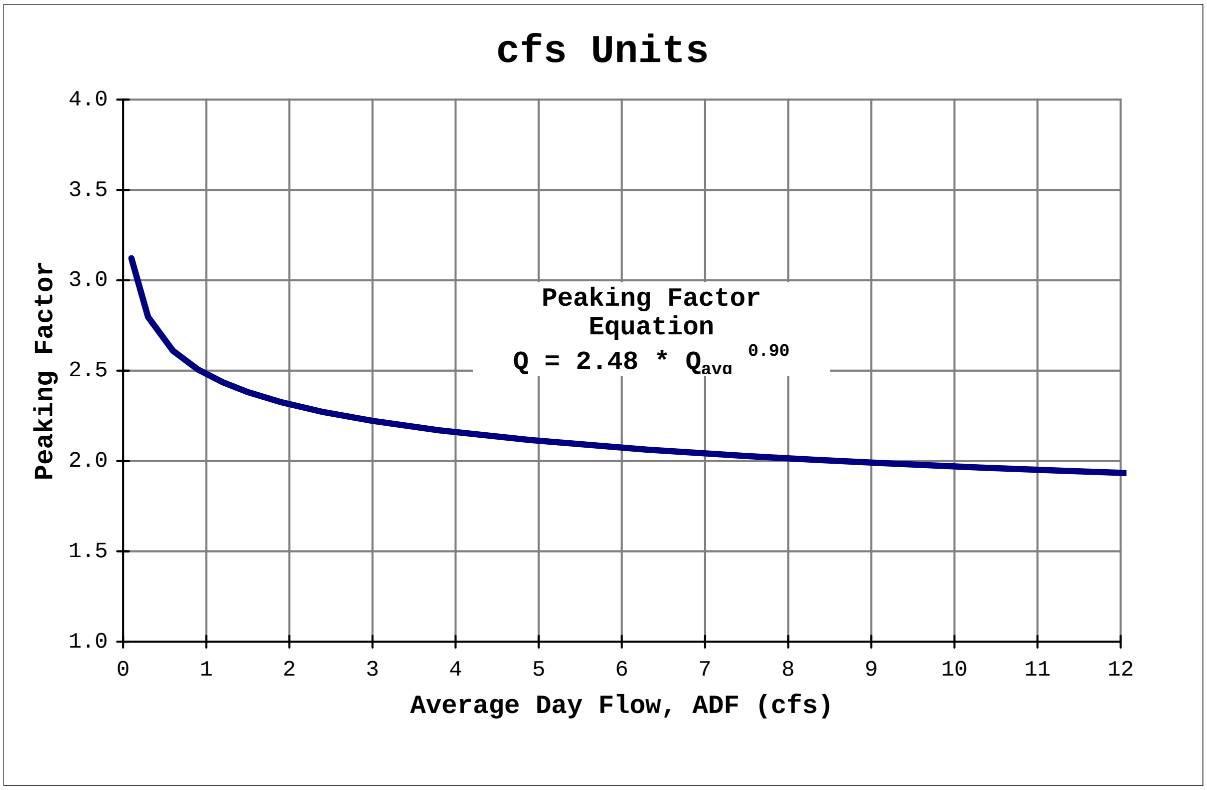
Land Use Category[1]	Land Use Code	Residential Density (DU/ga)	2020 UGB[1] (net acres)	Existing Sewer Service Area[5] (net acres)	Existing Sewer Service Area[5] (%)	Water Demand Coefficient (gpd/na)	Sewer Flow Coefficients: City Design Criteria		Sewer Flow Coefficients: Calculated Flows (gpd)	Adjusted Flow Coefficient[4] (gpd/na)	2000 Sewer ADWF Balance[3] (gpd)
Residential Estate	RE	< 1	1083	513	15%	360	90	gpdc	60,944	150	76,950
Single Family Low	SFL	1 - 3	1,144	597	17%	1,584	90	gpdc	343,872	650	388,050
Single Family Medium	SFM	3 - 5	1,734	1,083	31%	2,160	90	gpdc	935,712	900	974,700
Multi-Family Low	MFL	5 - 14	493	302	9%	3,168	90	gpdc	709,398	1,200	362,400
Multi-Family Medium	MFM	14 - 21	162	98	3%	4,608	90	gpdc	220,500	1,850	181,300
Commercial[4]	COM, GCOM, OIND, GIND, MIX		774	339	10%	2,016	1,500	gpd/ga	508,500	1,000	339,000
Industrial	IND		725	382	11%	2,592	2,500	gpd/ga	955,000	1,650	630,300
Open Space	OS		1,005	151	4%	720					
Public Facilites	PUB		238	45	1%	1,440					
Rural County	RC		448	6	0%						
Totals			7,806	3,516	100%				3,733,926		**2,952,700**

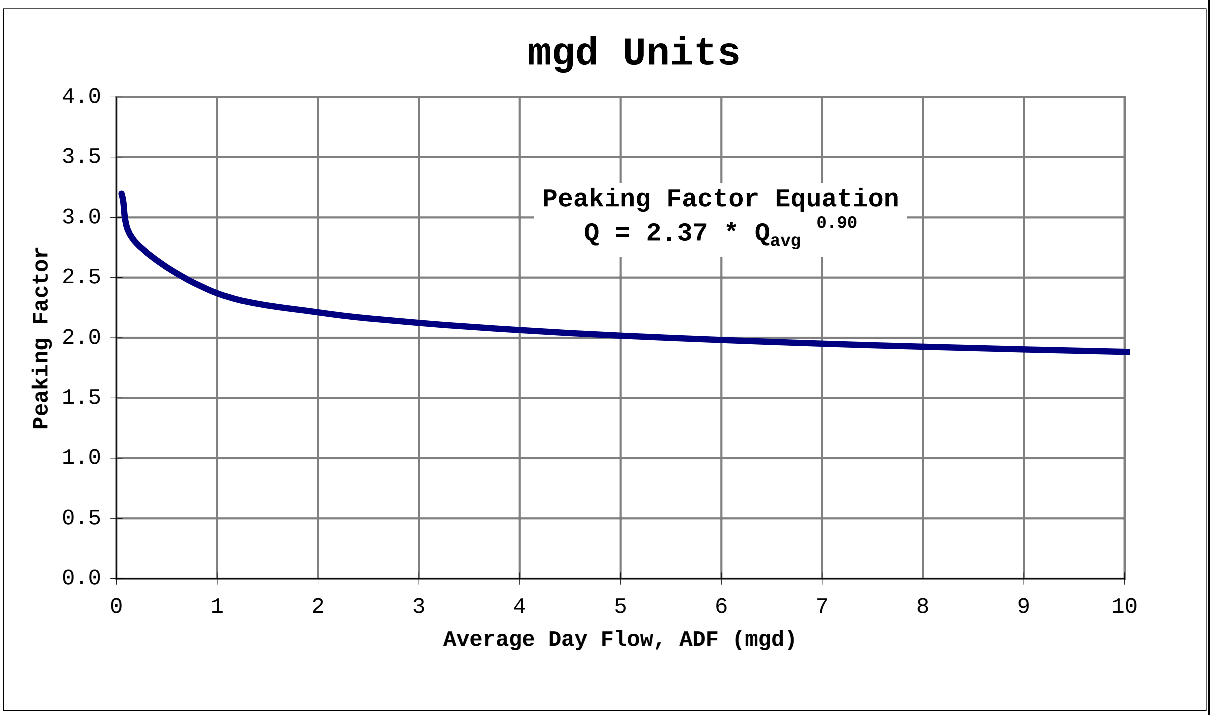
Notes:

1. Urban Growth Boundary, in accordance with the Update to the General Plan (March 2001). These areas are listed for comparison purposes.
2. In Morgan Hill, the City-wide residential occupancy averages at 3.19 people per dwelling units (California Department of Finance, 1999).
3. The 2000 sewer flows of 2.95 MGD were extracted from the WWTP in Gilroy metered records.
   The methodology for computing the balance consisted of proportional allocations based on existing service acreages and water demand coefficients established in the water system master plan. The distribution included adjustments to maintain a consistent total balance.
4. Commercial and Office Industrial categories have been consolidated into one category.
5. Existing Serviced Acreage. The percent was calculated by dividing the land use Serviced Acreage by the total Serviced Acreage.
6. Calculated by dividing the 2000 Water Balance amount (gpm) by the Existing Serviced Acreage.

6. Calculated by dividing the 2000 Water Balance amount (gpm) by the Existing Serviced Acreage.

Figure 3.6 **Dry Weather Sewer Flows Peaking Factor Curve**
Sewer System Master Plan
City of Morgan Hill





EXISTING SYSTEM AND HYDRAULIC MODEL

This chapter presents an overview of the City's sewer collection system. The chapter also describes the development and calibration of the City's Sewer Hydraulic Model. This model was used for identifying existing system deficiencies and for recommending enhancements.

4.1 SYSTEM OVERVIEW

The City of Morgan Hill sewer collection system consists of approximately 135 miles of 6-inch through 30-inch diameter sewers, and includes 15 sewage lift stations and associated force mains. The "backbone" of the system consists of the trunk sewers, generally 12-inches in diameter and larger, that convey the collected wastewater flows through an outfall that continues south of the City to the Gilroy Wastewater Treatment Facility (WWTF).

4.1.1 Trunk Sewers

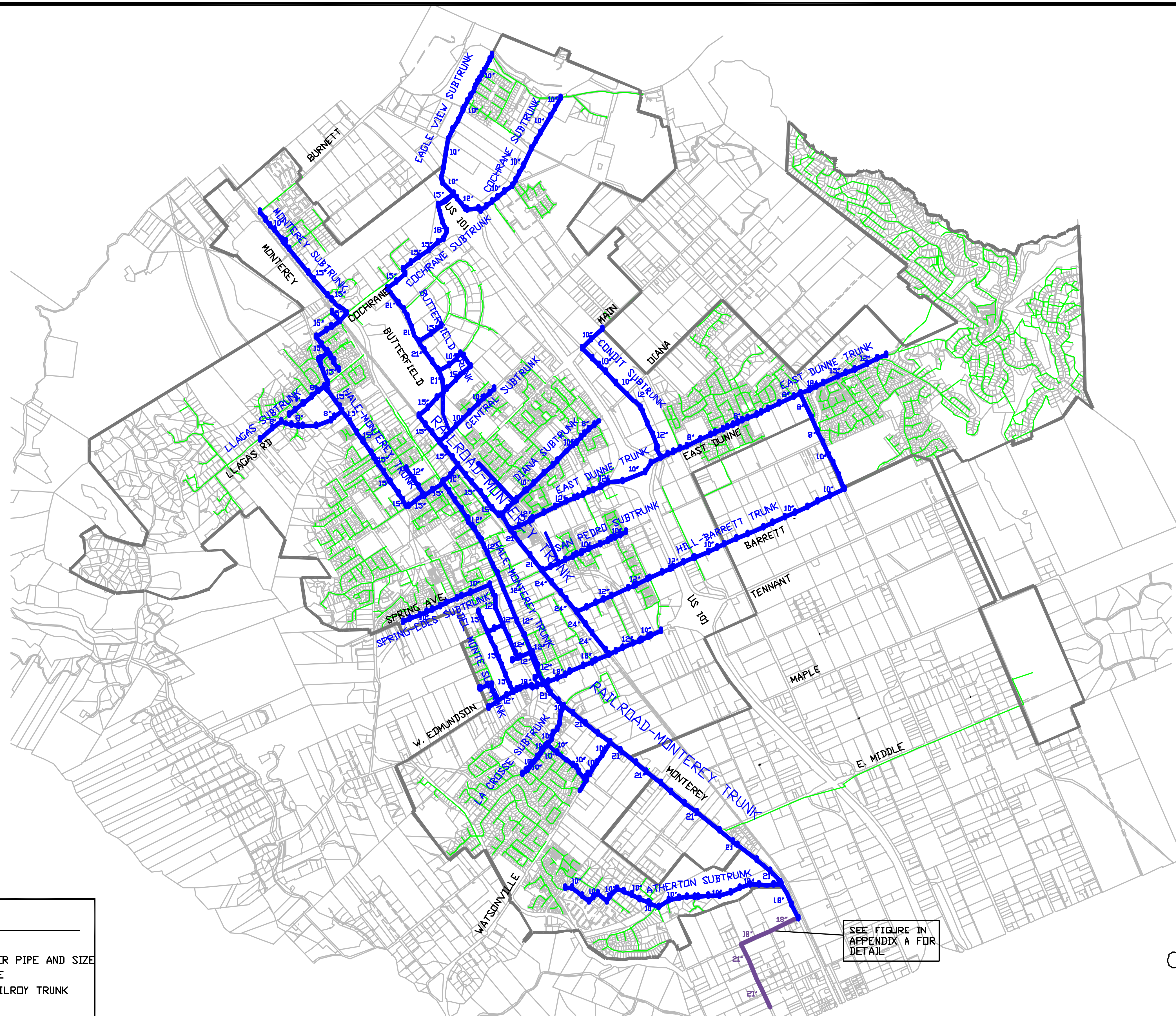
The major components of the City's trunk sewer system are shown on Figure 4.1, and their major alignments described below starting at the downstream end and continuing upstream. Each trunk sewer has been assigned a name that identifies it with the predominant street(s) alignment.

4.1.1.1 Railroad-Monterey Trunk

The Railroad-Monterey Trunk starts at the intersection of California Avenue and Monterey Avenue and continues northward along Monterey Avenue, with an 18-inch pipe, to the south side of Llagas Creek. It then continues northward along Monterey Avenue crossing Llagas Creek with a siphon, consisting of a 10-inch pipe and a 15-inch pipe, to the north side of Llagas Creek. It then continues northwesterly along Monterey Avenue, with a 21-inch pipe, to the intersection with Tennant Avenue. It then turns eastward on Tennant Avenue, with an 18-inch pipe, to the intersection with Railroad Avenue. The sewer continues northward along Railroad Avenue, with a 24-inch pipe then with a 21-inch pipe and finally with a 15-inch pipe, to the intersection with the extended alignment of Half Road.

4.1.1.2 Atherton Subtrunk

The Atherton Subtrunk is tributary to the Railroad-Monterey Trunk, and connects to that trunk at the intersection of Llagas Creek and Monterey Road. The sewer continues westward (upstream) along Llagas Creek, with a 12-inch pipe then a 10-inch pipe, to the intersection with Atherton Way. It then continues westward along Atherton Way, with a 10-inch pipe, to the intersection of Easy Street and the extended alignment of Water Avenue.



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N.T.S.

LEGEND

- STUDY AREA BOUNDARY
- EXISTING MODELED SEWER PIPE AND SIZE
- EXISTING 6' SEVER PIPE
- JOINT MORGAN HILL - GILROY TRUNK

FIGURE 4.1
EXISTING SEWER COLLECTION SYSTEM
CITY OF MORGAN HILL
MASTER PLAN

carollo engineers

It then turns northward, crossing Llagas Creek, with a 10-inch pipe, along Gallant Fox Way to the intersection with West Middle Avenue. It then turns westward along West Middle Avenue, with a 10-inch pipe, to the intersection with Native Dancer Drive. It then continues northward along Native Dancer Drive, with a 10-inch pipe, to the intersection of a property line approximately 375' north of West Middle Avenue. At this intersection, the trunk jogs westward along the property line, with a 10-inch pipe, and intersects Walnut Drive. It then continues northward along Walnut Drive, with a 10-inch pipe, to the intersection with Native Dancer Drive.

4.1.1.3 La Crosse Subtrunk

The La Crosse Subtrunk is tributary to the Railroad-Monterey Trunk, and connects to that trunk at the intersection of Vineyard Boulevard and Monterey Road. The sewer jogs southwesterly (upstream) along Vineyard Boulevard, with a 10-inch pipe, to the intersection with La Crosse Drive. It then continues westward along La Crosse Drive, with a 10-inch pipe, to the intersection with La Baree Drive.

4.1.1.4 Del Monte Subtrunk

The Del Monte Subtrunk is tributary to the Railroad-Monterey Trunk, and connects to that trunk at the intersection of West Edmundson Avenue and Monterey Road. The sewer continues westward (upstream) along West Edmundson Avenue, with an 18-inch pipe, to the intersection with the extended alignment of Del Monte Avenue. It then turns northward along the Del Monte Avenue extension, with a 15-inch pipe, to the intersection of Del Monte Avenue and Mathilda Court.

4.1.1.5 Hale-Monterey Trunk

The Hale-Monterey Trunk is tributary to the Railroad-Monterey Trunk, and connects to that trunk at the intersection of Tennant Avenue and Monterey Road. The trunk sewer continues northward (upstream) along Monterey Road, with a 12-inch pipe, to the intersection with Main Street. It then turns westward along Main Street, with a 15-inch pipe, to the intersection with Hale Avenue. It then turns northward and continues along Hale Avenue, with a 15-inch pipe, to Lift Station H south of Llagas Road.

The trunk continues northward, with a 15-inch pipe, to the intersection with a property line approximately 120' north of Berkshire Drive. It then turns eastward along the property line, with a 15-inch pipe, to the intersection of Del Monte Avenue. It then turns northward along Del Monte Avenue, with a 15-inch pipe, to the intersection with Sanchez Drive. The sewer then turns eastward along Sanchez Drive, with a 15-inch pipe, to the intersection with Little Llagas Creek. It then crosses under Little Llagas Creek, with a siphon consisting of an 8-inch pipe and a 6-inch pipe. The sewer continues along Sanchez Drive and crosses the railroad, with a 15-inch pipe, to the intersection of Monterey Road and Cochrane Road.

4.1.1.6 Monterey Subtrunk

The Monterey Subtrunk is tributary to the Hale-Monterey Trunk, and connects to that trunk at the intersection of Monterey Road and Cochrane Road. The sewer continues northward (upstream) along Monterey Road, with a 15-inch pipe, to a lift station approximately 250' north of Peebles Avenue. It then continues northward along Monterey Road, with a 10-inch pipe, to the intersection with Burnett Ave.

4.1.1.7 Spring-Edes Subtrunk

The Spring-Edes Subtrunk is tributary to the Hale-Monterey Subtrunk, and connects to that trunk at the intersection of Edes Court and Monterey Road. The sewer continues westward (upstream) along Edes Court, with a 12-inch pipe for a distance of 450 feet. It then continues northward in a direction parallel to Monterey Road, with a 12-inch pipe, to the intersection with Spring Avenue. It then continues westward along Spring Avenue, with a 10-inch pipe, to the intersection with Wild Oak Way.

4.1.1.8 Llagas Subtrunk

The Llagas Subtrunk is tributary to the Hale-Monterey Subtrunk, and connects to that trunk at the intersection of the extended alignment of Llagas Creek Drive and Hale Avenue. The sewer continues northwesterly (upstream), with an 8-inch pipe, to the intersection of Llagas Creek Drive and Llagas Road. It then continues westward on Llagas Road, with an 8-inch pipe, to approximately 500' west of the intersection with Enderson Court.

4.1.1.9 Hill-Barrett Trunk

The Hill-Barrett Trunk is tributary to the Railroad-Monterey Trunk, and connects to that trunk at the intersection of Railroad Avenue and Barrett Avenue. The sewer continues eastward (upstream) along Barrett Avenue, with a 12-inch pipe then with a 10-inch pipe, to the intersection with Hill Road. It then turns northward on Hill Road, with a 10-inch pipe then an 8-inch pipe, to the intersection with East Dunne Avenue.

4.1.1.10 San Pedro Subtrunk

The San Pedro Subtrunk is tributary to the Railroad-Monterey Trunk, and connects to that trunk at the intersection of San Pedro Avenue and Railroad Avenue. The sewer continues eastward (upstream) along San Pedro Avenue, with a 10-inch pipe, to the intersection with the extended alignment of Juan Hernandez Drive.

4.1.1.11 East Dunne Trunk

The East Dunne Trunk is tributary to the Railroad-Monterey Trunk, and connects to that trunk at the intersection of Railroad Avenue and East Dunne Avenue. The sewer trunk continues eastward (upstream) along East Dunne Avenue, with a 12-inch pipe then a 10-inch pipe, to the intersection with Condit Road. It then continues eastward, with an 8-inch pipe, to the intersection with Hill Road. It then continues eastward, with an 18-inch pipe then a 15-inch pipe then a 12-inch pipe, to the southeast extension of East Dunne Avenue.

4.1.1.12 Condit Subtrunk

The Condit Subtrunk is tributary to the East Dunne Trunk, and connects to that trunk at the intersection of Condit Road and East Dunne Avenue. The sewer trunk continues northward (upstream) along Condit Road, with a 12-inch pipe then a 10-inch pipe, to the intersection with Main Avenue. It then continues eastward along Main Avenue, with a 10-inch pipe.

4.1.1.13 Diana Subtrunk

The Diana Subtrunk is tributary to the Railroad-Monterey Trunk, and connects to that trunk at the intersection of Diana Avenue and Railroad Avenue. The sewer continues northeastwardly (upstream) along Diana Avenue, with a 10-inch pipe then an 8-inch pipe, to the intersection with Walnut Grove Drive.

4.1.1.14 Central Subtrunk

The Central Subtrunk is tributary to the Railroad-Monterey Trunk, and connects to that trunk at the intersection of Central Avenue and Railroad Avenue. The sewer continues northeastwardly (upstream) along Central Avenue, with a 10-inch pipe, to approximately 450' east of the intersection with Grand Prix Way.

4.1.1.15 Butterfield Trunk

The Butterfield Trunk is tributary to the Railroad-Monterey Trunk, and connects to that trunk at the intersection of Railroad Avenue and the extended alignment of Half Road. The trunk then continues eastward (upstream) along the Half Road extension, with a 15-inch pipe, to the intersection of Butterfield Boulevard. It then turns northward and continues along Butterfield Boulevard, with a 21-inch pipe, to the intersection of Cochrane Road.

4.1.1.16 Cochrane Subtrunk

The Cochrane Subtrunk is tributary to the Butterfield Trunk, and connects to that trunk at the intersection of Cochrane Road and Butterfield Boulevard. The trunk continues eastward (upstream) along Cochrane Road, with a 15-inch pipe, to the west side of US 101. It then turns northward along US 101, with an 18-inch pipe, to the intersection with the siphon crossing US 101. It then turns eastward crossing US 101 with a siphon, consisting of an 8-inch pipe and a 16-inch pipe, to the intersection of the extended alignment of Eagle View Drive and Cochrane Road. It then jogs southeasterly along Cochrane Road, with a 12-inch pipe then a 10-inch pipe, to the intersection with St. Louise Drive. It then continues northeasterly along Cochrane Road, with a 10-inch pipe, to the intersection with Malaguerra Avenue.

4.1.1.17 Eagle View Subtrunk

The Eagle View Subtrunk is tributary to the Cochrane Subtrunk, and connects to that trunk at the intersection of the extended alignment of Eagle View Drive and Cochrane Road. The trunk continues northeasterly (upstream) along the Eagle View Drive extension, with a 10-inch pipe, to the intersection of Malaguerra Avenue and Eagle View Drive.

4.1.2 Joint Morgan Hill – Gilroy Sewer Trunk

The City's sewer flows are conveyed via gravity pipes to the joint Morgan Hill - Gilroy sewer trunk (Joint Trunk) that continues south of the City (Figure 4.1). The Joint Trunk starts at the intersection of Monterey Avenue and California Avenue and continues south to the City of Gilroy where it joins the City of Gilroy trunk sewer for conveyance to the Wastewater Treatment Facility in Gilroy.

The Joint Trunk is maintained by a Joint Exercise of Powers Agreement between the City of Gilroy and the City of Morgan Hill (Appendix A). The agreement, which is dated May 19, 1992, establishes the creation of the South County Regional Wastewater Authority (SCRWA). The agreement includes an exhibit (Exhibit A) which lists the pipe capacities of the Joint Trunk and the capacity allocations for each trunk segment. The agreement maintains a 4.0 MGD capacity reservation for Morgan Hill in the Joint Trunk and a 7.5 MGD capacity reservation for Morgan Hill in the City of Gilroy trunk sewer system.

Design information on the Joint Trunk, which is approximately 5.8 miles in length, were obtained from City records, and summarized in Table 4.1. Pipe capacities were calculated and listed in for full flow and partial (75%) flow conditions.

4.1.3 Flow Diversions

Flow diversions serve the purpose of routing flows to relieve sewer trunks capacity limitations. The City's sewer system includes the following active diversions along the trunk sewer system:

East Dunne Avenue Diversion. This diversion is located on East Dunne Avenue, at the intersection with Hill Road. The existing trunk sewer lines east of Hill Road capture flows from the City's east foothills and route them to this intersection. The diversion allows flows that reach this intersection to either continue in a southwesterly direction along the East Dunne Trunk or to be diverted south to the Hill-Barrett Trunk. Though the diversion is currently configured to route the majority of sewer flows to the Hill-Barrett Trunk, it keeps some negligible flows running to the East Dunne Trunk for pipe cleaning purposes.

Table 4.1 Joint Morgan Hill - Gilroy Sewer Trunk
Sewer System Master Plan
City of Morgan Hill

Segment	Size	Length	Existing Capacity		Existing Capacity		Station Up	Station Dn	Invert Up	Invert Down	Drop	Calculated Slope	As-built Slopes	Paved	Comments
	(in)	(ft)	Q_{FULL} (cfs)	$Q_{75\%}$ (cfs)	Q_{FULL} (MGD)	$Q_{75\%}$ (MGD)			(ft)	(ft)	(ft)	(ft/ft)	(ft/ft)	(Y/N)	
1-2a	18	998	8.00	6.32	5.17	4.08	306+64	296+66	288.9	283.11	5.79	0.006	0.006	Y	California Ave, Monterey Rd to Colony Ave
1-2b	21	980	7.05	5.57	4.55	3.60	296+66	286+86	283.11	278.7	4.41	0.005	0.005	Y	California Ave, Colony to Harding Ave
2-3	21	3,140	8.38	6.62	5.41	4.28	286+86	255+46	278.45	269.66	8.79	0.003	0.003	N	Harding Ave, California to San Martin Ave
3-4	21	4,170	8.47	6.69	5.47	4.32	255+46	213+76	269.53	257.79	11.74	0.003	0.003	N	Continue from San Martin to Highland Ave
4-5	24	413	8.62	6.81	5.57	4.40	213+76	209+60	257.73	256.5	1.23	0.003	0.003	N	Jog west along Highland
5-6	24	1,185	10.12	7.99	6.54	5.16	209+85	198+00	256.28	253.91	2.37	0.002	0.002	N	Continue south from Highland
6-7a	24	1,500	13.80	10.90	8.91	7.04	198+00	183+00	253.91	248.33	5.58	0.004	0.004	N	Continue south to Fitzgerald Ave
6-7b	24	4,277	13.36	10.56	8.63	6.82	183+00	140+23	248.33	233.48	14.85	0.003	0.003	N	Continue south to Fitzgerald Ave
6-7c	24	335	12.39	9.79	8.00	6.32	140+23	136+88	233.3	232.3	1.00	0.003	0.003	N	Continue south to Fitzgerald Ave
7-8	24	2,316	10.90	8.61	7.04	5.56	136+88	113+72	232.2	226.82	5.38	0.002	0.002	N	Continue south from Fitzgerald
8-9a	24	1,469	10.90	8.61	7.04	5.56	113+72	99+03	226.82	223.42	3.40	0.002	0.002	N	Jog southeast
8-9b	24	1,903	13.00	10.27	8.40	6.63	99+03	80+00	223.42	217.15	6.27	0.003	0.003	N	Jog southeast
9-10	27	2,063	15.85	12.52	10.24	8.09	80+00	59+37	216.9	211.46	5.44	0.003	0.003	N	Continue south to Day Road
10-11	30	2,786	17.83	14.09	11.52	9.10	59+27	31+41	211.23	205.97	5.26	0.002	0.002	N	Continue South from Day to Wren Ave
11-12	30	1,091	16.46	13.00	10.63	8.40	31+41	22+57	205.91	204.16	1.75	0.002	0.002	Y	Farrell Ave, Wren to Church Street
12-13a	18	1,055	4.08	3.22	2.64	2.08	22+57	12+02	204.16	202.53	1.63	0.002	0.002	Y	Church Street, Farrell to Ronan Ave
12-13b	18	1,202	4.21	3.33	2.72	2.15	12+02	0+00	202.53	200.6	1.93	0.002	0.002	Y	Church Street, Farrell to Ronan Ave
13-14	Gilroy Trunk		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	Y	Gilroy Trunk
Total		30,883													
Miles of Pipe		5.85													

Notes:
1. See Appendix A for Agreement with SCRWA
2. Station at California & Harding (from as-builts) 286+76.4, w/ invert of 278.45', slope .0028
3. Station at Roosevelt is 268+76.4 (286+76.4 - 18+00)
3. Station at Roosevelt is 268+76.4 (286+76.4 - 18+00)
4. The City of gilroy maintains other sewers that provides a relief to the 18-inch Segment 12-13.

- West Main Avenue Diversion. This diversion is located on Main Avenue, at the Intersection with Monterey Street. The diversion allows flows from the Hale-Monterey Trunk to continue eastward along West Main Avenue via the existing 15-inch trunk sewer to the Railroad-Monterey Trunk. Alternately, the diversion allows flows to continue along the Hale-Monterey Trunk via the existing 12-inch trunk sewer along Monterey Avenue. The diversion is currently configured to route all flows to the Railroad Monterey Trunk.

4.1.4 Hydraulic Model

Hydraulic network analysis is a powerful tool used in sewer collection planning, design, operation, management, and emergency response. Morgan Hill's hydraulic sewer model is a critical element that was used in evaluating the capacity of the City's existing sewer system and in planning the City's future facilities.

4.1.5 Selected Hydraulic Model

There is an abundance of sewer analysis software in the marketplace today, with a variety of features and capabilities. The selection of a particular model generally depends on user preferences, software costs, and the complexity of the sewer system. It was agreed that Hydra version 6 would be used by Carollo Engineers to assemble the City's hydraulic model. Hydra consists of multiple products that work together to bring a graphical approach to the analysis and design of sanitary sewer collections systems. The Hydra program includes GIS Master, which is an AutoCAD "add-on" tool that facilitates the assembly of the hydraulic model.

4.1.6 Elements of the Hydraulic Model

The City's hydraulic model combines information on the physical and operational characteristics of the sewer system, and performs calculations to solve a series of mathematical equations to simulate flows in pipes. Elements comprising the computer modeling process are: skeletonizing the sewer system, defining pipes and nodes, and identifying the service areas.

4.1.6.1 Skeletonizing

Skeletonizing is the process by which sewer systems are stripped of pipelines not considered essential for the intended analysis purpose. The purpose of skeletonizing a system is to develop a model that accurately simulates the hydraulics of the pipelines collecting sanitary sewer flows. At the same time, skeletonizing should reduce the complexity of the large model, minimizing the time of analysis, and comply with the limitations imposed by the computer program.

The "backbone" of the Morgan Hill sewer system were included in the hydraulic model. These pipes are generally 12 inches in diameter and larger and function to convey the wastewater collected in the City to the outfall that continues to the Gilroy WWTF. The modeled trunk system was described in detail in a previous section and shown on Figure 4.1.

4.1.6.2 Pipes and Manholes

Computer modeling requires gathering detailed numerical information on the physical characteristic of the modeled sewer system, such as pipe sizes (diameters), pipe lengths, pipe invert elevations at the upstream and downstream manholes, pipe slope, ground elevations at the manholes, and general system geometry.

Pipes and manholes represent the physical elements describing the sewer system. A manhole represents a location in the network where a sewer flow can be applied to the trunk sewer system, while a pipe segment represents an element of the actual collection system. Additionally, pumps and diversion within the skeletonized system are included in the computer model.

4.1.6.3 Sewer Tributary Areas

Allocating sewer flows to appropriate locations throughout the trunk system was accomplished by defining sewer areas tributary to individual manholes, identifying the areas (acres) of sewer user groups within each service area, then applying the appropriate average day demand coefficients to each sewer user group in those areas. Sewer flow distribution was performed based on the land use categories generating flows in accordance with the developed average day demand conditions. These coefficients were defined and discussed in a previous chapter.

4.1.7 Hydraulic Model Calibration

Morgan Hill’s hydraulic model was calibrated to establish a level of confidence in the flows that it simulates. The calibrated model serves as an established benchmark for further analysis and evaluation. Future analysis consisted of modifications to the calibrated model to simulate other sewer flow patterns or additional facilities.

Calibration is complicated by the fact that some data are known and unchanging, some are variable over time, while others are estimated. Pipe and manhole information such as diameter, lengths, slopes, and location are known. Flow data obtained from the WWTF records and from the flow monitoring program, vary with time of day, season, and total number of customers. Morgan Hill's model was calibrated for the flows simulated during the flow monitoring period of January and February 2000.

EVALUATION AND PROPOSED IMPROVEMENTS

This chapter presents the results of the capacity evaluation of the sewer system. The chapter also presents improvements to mitigate existing system deficiencies and for servicing future growth. These improvements are recommended based on the system's technical requirements, cost effectiveness, and operational reliability.

5.1 DESIGN FLOWS

Based on the evaluation criteria discussed in a previous chapter, existing and projected 2020 design flows were simulated to evaluate the capacity adequacy of the existing collection system. The projected 2020 design flows consist of the General Plan buildout conditions of the Urban Growth Boundary. The design flows (Table 5.1) included dry weather and wet weather conditions.

5.1.1 Dry Weather Conditions

During existing dry weather conditions, the average flow and peak hour flows from the City of Morgan Hill are 2.9 and 4.1 MGD, respectively. At buildout of the 2020 Urban Growth Boundary, the average and peak hour dry weather flows are anticipated to approach 5.2 and 6.9 MGD, respectively.

5.1.2 Wet Weather Conditions

Wet weather flows are based on a recent infiltration and inflow analysis conducted by another consultant that included a temporary flow monitoring program between January 4 and April 17, 2001 (Appendix B). The infiltration and inflow analysis identified the wet weather flow components experienced in the existing system. Evaluating the capacity adequacy of the City's sewer system included applying a hypothetical 5-year 24-hour design storm that increased the currently experienced infiltration and inflows.

Should the design storm occur, the hydraulic model projects existing average and peak hour flows of 5.9 MGD and 12.0 MGD, respectively. Applying the same storm event during the buildout condition of the General Plan results with an average and peak hour flows of 8.1 MGD and 14.6 MGD, respectively. These projected wet weather flows assume no mitigation to the current infiltration and inflow rates.

However, the City has an aggressive wet weather program to reduce infiltration and inflows (RDII) that are currently experienced by the system. In accordance with City staff, this study assumes that the City's RDII will be reduced by approximately 50 percent by the year 2020. In that scenario, the wet weather average and peak hour flows for buildout of the UGB are reduced to 6.6 MGD and 10.0 MGD, respectively.

Table 5.1 Design Flows Sewer System Master Plan City of Morgan Hill		
Design Flow Condition	**Average Flow (MGD)**	**Peak Hour Flow (MGD)**
Dry Weather Conditions		
2001 Dry Weather	2.9	4.1
2020 Dry Weather	5.2	6.9
Wet Weather Conditions		
2001 Wet Weather with No Reduction in RDII	5.9	12.0
2020 Wet Weather with No Reduction in RDII	8.1	14.6
2020 Wet Weather with 50 percent Reduction in RDII	6.6	10.0

5.2 PROPOSED IMPROVEMENTS

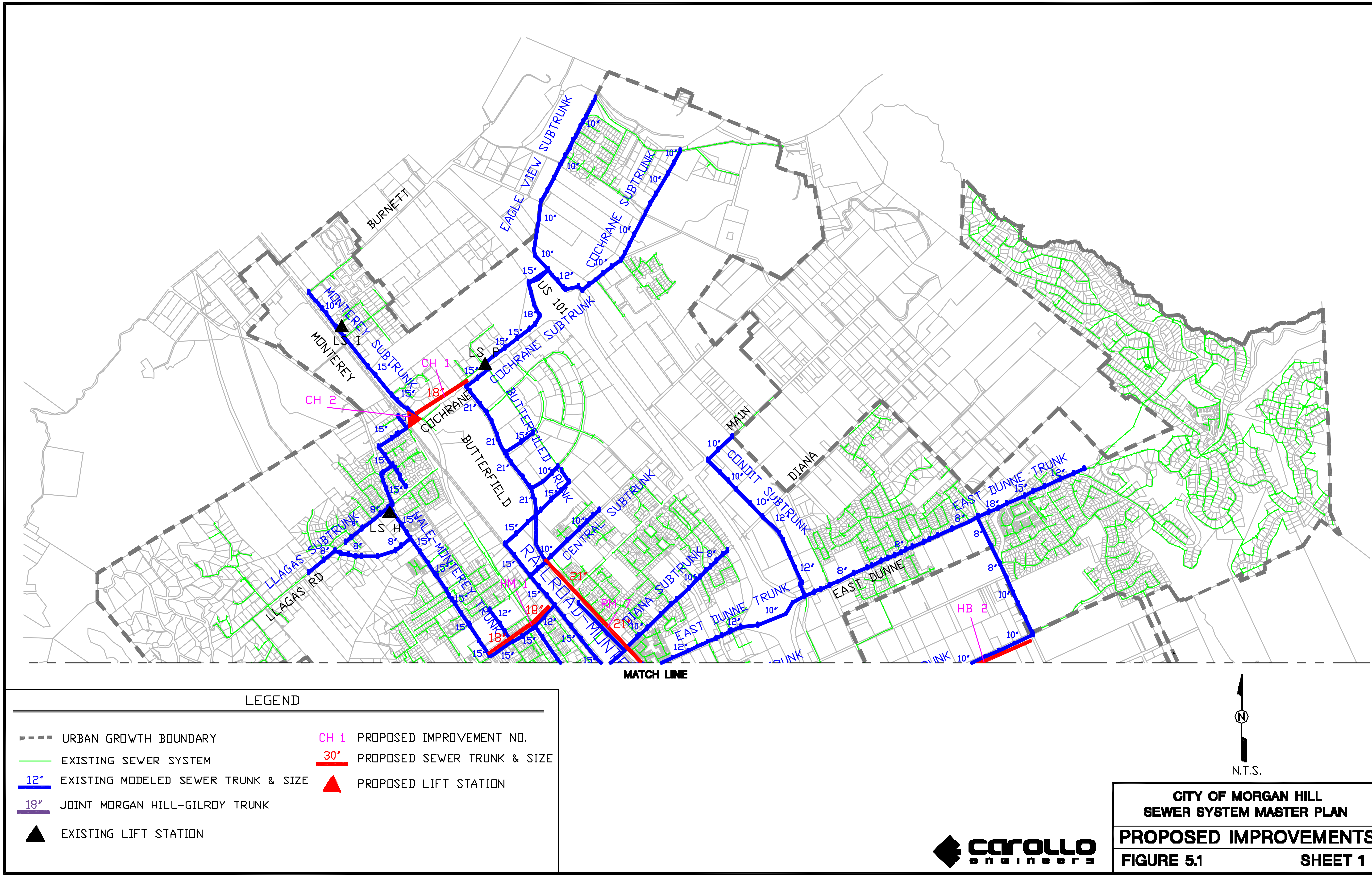
The recommended improvements discussed in this section are needed to mitigate existing system deficiencies. They are quantified in the Capital Improvement Program (CIP), presented in the following chapter and shown on Figure 5.1. Though some 8-inch sewer mains were included in this study, it is impractical to include new small sewer mains (8-inches and smaller) in a master planning effort. It should be noted that developers are still responsible for paying an equitable cost allocation for the infrastructures needed to extend service from their developments to the master plan facilities.

Since this Study did not include a condition assessment, it assumes replacement of deficient sewers. During the preliminary design phase of these sewers, City staff may decide to parallel the existing pipes rather than replace them. In the case of the Joint Trunk, the study recommends a parallel relief that will be dedicated to the City of Morgan Hill flows.

5.2.1 Joint Morgan Hill–Gilroy Trunk

The capacity evaluation of the Joint Trunk indicates no deficiency during current dry weather flows. Furthermore, City staff indicates that recent records do not indicate of surcharging during wet weather flows. Using a 5-year 24-hour design storm, with the projected infiltration and inflow rates, the hydraulic model indicates the likelihood of surcharges. The study recommends paralleling the existing Joint Trunk for redundancy and reliability.

The design criterion for sizing the new Relief Sewer assumes a 50 percent reduction in the City’s infiltration and inflows at the buildout of the UGB. The new sewer consists of mainly 24-inch pipelines with a portion (Segments 1-2) consisting of a 21-inch pipe.



CITY OF MORGAN HILL
SEWER SYSTEM MASTER PLAN

PROPOSED IMPROVEMENTS

FIGURE 5.1 SHEET 1

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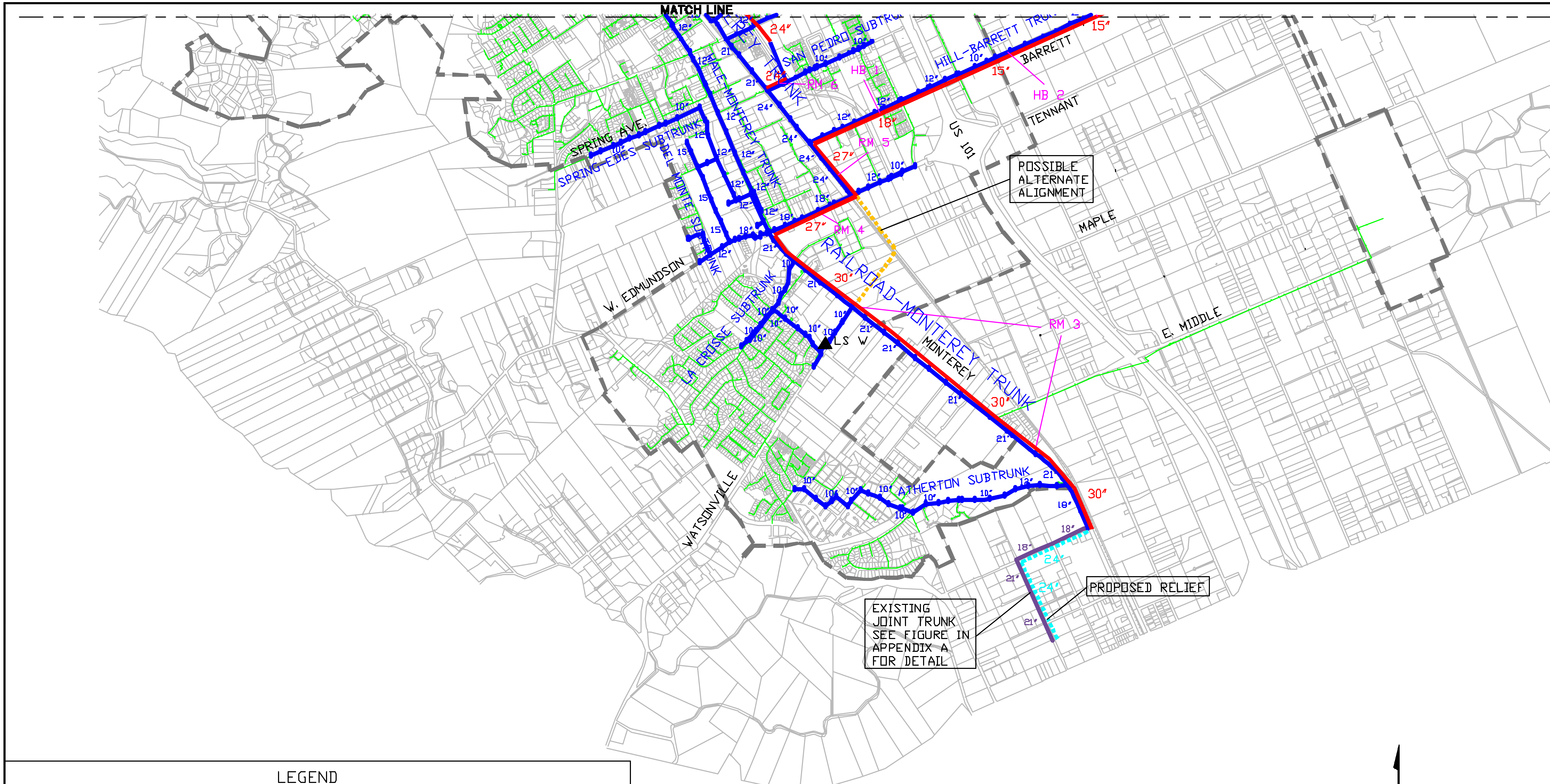

LEGEND

- URBAN GROWTH BOUNDARY
- EXISTING SEWER SYSTEM
- 12" EXISTING MODELED SEWER TRUNK & SIZE
- 18" JOINT MORGAN HILL-GILROY TRUNK
- EXISTING LIFT STATION
- CH 1 PROPOSED IMPROVEMENT NO.
- 30" PROPOSED SEWER TRUNK & SIZE
- PROPOSED LIFT STATION

carollo engineers

CITY OF MORGAN HILL
SEWER SYSTEM MASTER PLAN

PROPOSED IMPROVEMENTS

FIGURE 5.1 **SHEET 2**

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5.2.2 Railroad-Monterey Trunk

The capacity analysis indicates that this trunk, like the Joint Trunk that continues to the south, is currently deficient during wet weather conditions. The study recommends a 30-inch new pipe to replace the existing sewer along Monterey Road.

5.2.3 Monterey Subtrunk

Growth in the northern part of the City has resulted with a deficiency in the Hale-Monterey Trunk and in Lift Station H. Mitigating this deficiency can be accomplished by diverting flows from the Monterey Subtrunk to the Butterfield Trunk. A new lift station will capture flows from the Monterey Subtrunk and route flows through a new 18-inch trunk sewer that continues east to Butterfield Avenue. The lift station will be located near the intersection of Old Monterey Road and Cochrane Road.

5.2.4 Hale-Monterey Trunk

The deficiency in the trunk will be mitigated by diverting flows from the Monterey Subtrunk to the Butterfield Trunk via the proposed lift station. Improvements within this trunk include replacing the existing 12-inch portion along West Main Avenue, between Hale Avenue and Railroad Avenue, with a new 18-inch pipe.

5.2.5 Butterfield Trunk

City staff, in anticipation of future growth, have already constructed portions of this trunk. The proposed improvements will continue the construction of a 21-inch sewer pipe on Butterfield Avenue, between Central Avenue and East Dunne Avenue. This improvement also includes a portion along San Pedro Avenue, between Butterfield Avenue and Railroad Avenue.

5.2.6 Barrett-Hill Trunk

The proposed improvement for this trunk consists of a new 18-inch pipe to replace the existing 12-inch on Barrett Avenue, west of Highway 101. The portion that continues east of Highway 101 consists of a new 15-inch pipe that replaces the existing 10-inch sewer.

Table 5.2 Joint Morgan Hill - Gilroy Trunk Analysis
Sewer System Master Plan
City of Morgan Hill

Design Data				Calculated Capacity		SCRWA Capacity Allocation			Dry Weather Flow Analysis						Wet Weather Flow Analysis						Proposed Improvements					
									2001			Buildout of UGB			2001 (no Reduction in RDII)			Buildout of UGB (50% Reduction in RDII)			Dry - Buildout of UGB		Wet - 2001 (No Reduction in RDII)		Wet - Buildout of UGB (50% Reduction in RDII)	
Segment	Size (in)	Existing Slope	Length (ft)	Q_{Full} (MGD)	$Q_{75\%}$ (MGD)	Total (MGD)	MH (MGD)	Gilroy (MGD)	Avg Flow (MGD)	Peak Flow (MGD)	Def. Q (MGD)	Avg Flow (MGD)	Peak Flow (MGD)	Def. Q (MGD)	Avg Flow (MGD)	Peak Flow (MGD)	Def. Q (MGD)	Avg Flow (MGD)	Peak Flow (MGD)	Def. Q (MGD)	Parallel Pipe Q_{Full}	Replace Pipe Q_{Full}	Parallel Pipe Q_{Full}	Replace Pipe Q_{Full}	Parallel Pipe Q_{Full}	Replace Pipe Q_{Full}
1-2a	18	0.006	998	5.2	4.1	4.0	4.0	0.0	2.9	4.1	0.1	5.2	6.9	2.9	5.9	12.0	8.0	6.6	10.0	6.0	15	24	21	24	21	24
1-2b	18	0.005	980	4.6	3.6	4.0	4.0	0.0	2.9	4.1	0.1	5.2	6.9	2.9	5.9	12.0	8.0	6.6	10.0	6.0	15	24	24	27	21	24
2-3	21	0.003	3,140	5.4	4.3	5.5	4.0	1.5	2.9	4.1	0.1	5.2	6.9	2.9	5.9	12.0	8.0	6.6	10.0	6.0	18	24	24	30	24	27
3-4	21	0.003	4,170	5.5	4.3	5.5	4.0	1.5	2.9	4.1	0.1	5.2	6.9	2.9	5.9	12.0	8.0	6.6	10.0	6.0	18	24	24	30	24	27
4-5	24	0.003	413	5.6	4.4	5.7	4.0	1.7	2.9	4.1	0.1	5.2	6.9	2.9	5.9	12.0	8.0	6.6	10.0	6.0	18	24	24	30	24	27
5-6	24	0.002	1,185	6.5	5.2	6.6	4.0	2.6	2.9	4.1	0.1	5.2	6.9	2.9	5.9	12.0	8.0	6.6	10.0	6.0	18	24	27	30	24	27
6-7a	24	0.004	1,500	8.9	7.0	8.7	4.0	4.7	2.9	4.1	0.1	5.2	6.9	2.9	5.9	12.0	8.0	6.6	10.0	6.0	18	24	27	30	24	27
6-7b	24	0.003	4,277	8.6	6.8	8.7	4.0	4.7	2.9	4.1	0.1	5.2	6.9	2.9	5.9	12.0	8.0	6.6	10.0	6.0	18	24	27	30	24	27
6-7c	24	0.003	335	8.0	6.3	8.7	4.0	4.7	2.9	4.1	0.1	5.2	6.9	2.9	5.9	12.0	8.0	6.6	10.0	6.0	18	24	27	30	24	27
7-8	24	0.002	2,316	7.0	5.6	7.0	4.0	3.0	2.9	4.1	0.1	5.2	6.9	2.9	5.9	12.0	8.0	6.6	10.0	6.0	18	27	27	30	24	27
8-9a	24	0.002	1,469	7.0	5.6	8.5	4.0	4.5	2.9	4.1	0.1	5.2	6.9	2.9	5.9	12.0	8.0	6.6	10.0	6.0	18	27	27	30	24	27
8-9b	24	0.003	1,903	8.4	6.6	8.5	4.0	4.5	2.9	4.1	0.1	5.2	6.9	2.9	5.9	12.0	8.0	6.6	10.0	6.0	18	27	27	30	24	27
9-10	27	0.003	2,063	10.2	8.1	10.3	4.0	6.3	2.9	4.1	0.1	5.2	6.9	2.9	5.9	12.0	8.0	6.6	10.0	6.0	18	27	27	30	24	27
10-11	30	0.002	2,786	11.5	9.1	11.5	4.0	7.5	2.9	4.1	0.1	5.2	6.9	2.9	5.9	12.0	8.0	6.6	10.0	6.0	18	27	27	30	24	27
11-12	30	0.002	1,091	10.6	8.4	10.8	3.1	7.7	2.9	4.1	1.0	5.2	6.9	3.8	5.9	12.0	8.9	6.6	10.0	6.9	18	27	27	30	24	27
12-13a	18	0.002	1,055	2.6	2.1	2.7	1.37	1.37	2.9	4.1	2.7	5.2	6.9	5.5	5.9	12.0	10.6	6.6	10.0	8.6	18	27	27	30	24	27
12-13b	18	0.002	1,202	2.7	2.2	2.7	1.37	1.37	2.9	4.1	2.7	5.2	6.9	5.5	5.9	12.0	10.6	6.6	10.0	8.6	18	27	27	30	24	27
13-14	GILROY TRUNK			n/a	n/a	n/a	7.50	n/a	2.9	4.1		5.2	6.9		5.9	12.0	4.5	6.6	10.0	2.5	n/a	n/a	n/a	n/a	n/a	n/a

CAPITAL IMPROVEMENT PROGRAM

This chapter presents the recommended Capital Improvement Program (CIP) for the City of Morgan Hill sewer system. The program is based on the evaluation of the City's sewer system, and on the recommended projects described in the previous chapters. The CIP has been staged to the planning horizon year of 2020.

6.1 COST ESTIMATING CRITERIA

The cost estimates presented in this study are opinions developed from bid tabulations, cost curves, information obtained from previous studies, and Carollo Engineers experience on other projects. The costs estimated for each recommended facility are opinions included in the Capital Improvement Program (CIP) tables developed with this study. The tables are intended to be used to facilitate revisions to the City's CIP, and ultimately to support determination of the user rates and connection impact fees. Recommendations for cost criteria of pipelines and pump stations are also presented.

6.1.1 Cost Estimating Accuracy

The cost estimates presented in the Capital Improvement Program have been prepared for general master planning purposes and for guidance in project evaluation and implementation. Final costs of a project will depend on actual labor and material costs, competitive market conditions, final project scope, implementation schedule, and other variable factors such as: preliminary alignments generation, investigation of alternative routings, and detailed utility and topography surveys.

The American Association of Cost Engineers defines three types of cost estimates:

- An Order of Magnitude Estimate for Master Plan Studies. This is an approximate estimate made without detailed engineering data. It is normally expected that an estimate of this type would be accurate within +50 percent to -30 percent.
- A Budget Estimate for Predesign Study. A budget estimate is prepared with the use of flow sheets, layouts, and equipment details. It is normally expected that an estimate of this type would be accurate within +30 percent to -15 percent.
- A Definite Estimate (Engineer's Estimate) for Time of Contract Bidding. This estimate is prepared from very defined engineering data. The data includes fairly complete plot plans and elevations, soil data, and a complete set of specs. It is expected that a definite estimate would be accurate within +15 to -5 percent.

Costs developed for this study should be considered "order of magnitude" and have an expected accuracy range of +50 percent to -30 percent. The purpose of this chapter is to present the assumptions used in developing order of magnitude cost estimates for facilities recommended with this master plan. Recommended facility improvements, which will address current deficiencies and facilities required to meet future City needs are presented within the body of the report.

6.1.2 Pipelines

Pipeline improvements to the City range in size from approximately 8-in to 36-inch in diameter. Costs associated with pipelines ranging in size from 8 inches to 36 inches are shown on Table 6.1.

Table 6.1 Pipeline Costs
Sewer System Master Plan
City of Morgan Hill

Pipe Size (inches)	$/Lineal Foot
8	120
10	130
12	140
15	190
18	220
21	260
24	300
27	350
30	400
33	450
36	500

6.1.3 Pump Stations

Costs associated with new pump station facilities include electrical, instrumentation, pumps, piping, pump station building, and other appurtenances required for a finished pump station. Costs not included are fencing, landscaping, road work, and piling. These items are not known at this time and may be considered a part of the contingency.

6.1.4 Land Acquisition

Acquisition of property, easements, and right-of-way (ROW) will be required for some of the recommended projects, particularly new pump stations. Additionally, the capital costs do not include pipeline corridor purchases or easement costs because it was assumed that public right-of-way will be utilized wherever possible. Land costs in Santa Clara County are not easily determined, particularly in the master planning phase, and variables affecting properties can result in widely varying land prices. Since land acquisition costs are not included in this master plan, the final capital costs may vary from the estimates presented herein.

6.1.5 Construction Cost Index Adjustments

Costs estimated with this study will be adjusted utilizing the Engineering News Record (ENR) construction cost index (CCI). The ENR CCI is the primary index utilized by the water planning and engineering community to adjust cost estimates developed in different years. The costs estimated for facilities with this study are in 2001 dollars, based on an ENR CCI for San Francisco of 7409 (July 2001).

6.2 CAPITAL IMPROVEMENT PROGRAM

The Capital Improvement Program for the improvements identified by this master plan are presented in Table 6.2. Care was taken to explain each column, in the previous chapter, additional cost-related explanations are provided herein.

6.2.1 Baseline Construction Cost

This is the total estimated construction cost, in dollars, of the proposed improvement: pipes and pump stations. Pipe Baseline Construction Costs were developed using the following criteria:

- Pipe Unit Cost: Estimated unit cost of pipeline is based on the pipe's present day cost in addition to installation cost, new pavement or pavement restoration, traffic control, bore- and-jack installation (where applicable), and appurtenance such as valves and fire hydrants, mobilization and demobilization, and contractor's overhead and profit. The cost is expressed in dollars per linear foot ($/LF) of pipe length. In the case of jacked steel casings, the unit cost includes the carrier pipe inside the casing.
- Pipe Cost: Estimated cost of the pipeline, calculated by multiplying the estimated length by the unit cost, in dollars.
- Other Infrastructure Facilities Costs: Estimated lump sum costs, in dollars, for the construction of pump stations.

6.2.2 Estimated Construction Cost

Since knowledge about site-specific conditions of each proposed project is limited at the master planning stage, a 30 percent contingency was applied to the Baseline Construction Cost to account for unforeseen events and unknown conditions.

The Estimated Construction Cost, in dollars, for the proposed improvement consists of the Baseline Construction Cost plus the construction contingency.

6.2.3 Capital Improvement Cost

Other project-related costs have been identified and estimated at 30 percent of the Estimated Construction Costs. These costs include engineering, administration, construction inspection, and legal costs.

The Capital Improvement Cost, in dollars, for each proposed improvement is the total of the Estimated Construction Cost (including contingency) plus the other costs discussed in the previous paragraph.

6.2.4 Capital Improvement Program

The Capital Improvement Program Costs were prioritized based on their urgency to mitigate existing deficiencies and for servicing anticipated growth. The deficiencies in the existing system have a significant total capital cost that is best distributed based on the City's historical ability to construct new infrastructure projects. The City's current capability is approximated at $2,000,000 a year.

The City is capable of allocating larger resources and will perform updated reassessments as needed.

The Program has been divided into the following phases:

- Phase I: This Short-Term Phase includes improvements that are allocated based on annual fiscal budgets between 2002 and 2005.
- Phase II: This Intermediate Phase includes improvements that are allocated based on a 5-year period between 2005 and 2010.
- Phase III: This Long-Term Phase includes improvements that are distributed based on a 10-year period between 2010 and 2020. Some improvements needed beyond 2020 are also included.

6.3 FUNDING AND FINANCING OPTIONS

Utility rates and connection fees are collected to pay off debt financing, to fund capital improvements and to pay operations and maintenance costs. Connection fees are charges, imposed by local agencies on new developments, for recovering the capital costs of public facilities needed to service those developments. These fees and charges must satisfy the provisions of California Government Code Section 66000 which went into effect on January 1, 1989. These provisions, for water and sewer connection fees, are also known as AB1600 provisions, referring to Assembly Bill 1600 that introduced the provision. The provisions, as they relate to water and sewer connection fees, dictate that the ".... charges do not exceed the estimated reasonable cost of providing the service for which the fee or charge is imposed..."

The improvements in this master plan have been classified into two categories:

- Services benefiting existing development.
- Services necessitated by or benefiting new development.

An opinion of benefit to future users, based on preliminary project information, was included in this master plan. Once estimates for specific projects are completed, a more precise allocation may be performed if required by the provisions of the California Government Code Section 66000 and AB 1600.

New development is defined as any land use change or construction that takes place after the funding procedures recommended in this plan are adopted. Existing development includes properties where no new construction or redevelopment occurs.

Due to state law and political realities, the funding and financing options available differ somewhat for these two categories. Appendix H first presents the funding and financing options applicable to existing developments, followed by those applicable to new developments.

Table 6.2 Capital Improvement Program
Sewer System Master Plan
City of Morgan Hill

Itemized Cost Estimate

No.	Coded No.	Type of Improv.	Description/ Street	Description / Limits	Pipeline and App. Costs: Size/ Diam. (in)	Parallel/ Replace	Length (ft)	Unit Cost ($)	Pipe Cost ($)	Other Infrastr. Costs ($)	Baseline Constr. Cost ($)	Estim. Constr. Cost[3] ($)	Capital Improv. Cost[4] ($)
	Morgan Hill - Gilroy Joint Trunk												
1	WWTF-1	Plant Expansion		Sewer Plant Improvement Project						note 6			note 6
1A	WW-1	Pipe	Joint Trunk	n/o City of Gilroy to Gilroy WWTF	24	Parallel	31,000	250	7,750,000		7,750,000	10,075,000	13,098,000
	Railroad-Monterey Trunk												
2	RM-3A	Pipe	Monterey St.	California Ave. to s/o Creek	30	Replace	1,200	400	480,000		480,000	624,000	811,000
3	RM-3B	Casing[1]	Monterey St.	Crossing under the Creek	30/50	Replace	550	700	385,000		385,000	500,500	651,000
4	RM-3C	Pipe	Monterey St.	n/o Creek to Watsonville Rd.	30	Replace	6,500	400	2,600,000		2,600,000	3,380,000	4,394,000
5	RM-3D	Pipe	Monterey St.	Watsonville Rd. to Tennant Rd.	30	Replace	2,900	400	1,160,000		1,160,000	1,508,000	1,960,000
6	RM-4A	Pipe	Tennant Ave.	Monterey Rd. to e/o Railroad	27	Replace	2,150	350	752,500		752,500	978,250	1,272,000
7	RM-4B	Casing[1]	Tennant Ave.	Crossing under RR, e/o Railroad Ave.	27/48	Replace	80	670	53,600		53,600	69,680	91,000
8	RM-5	Pipe	Railroad Ave.	Tennant Ave. to Barrett Ave.	27	Replace	1,750	350	612,500		612,500	796,250	1,035,000
9	RM-6	Pipe	San Pedro Ave.	Railroad Ave. to Butterfiled Blvd.	24	Replace	650	300	195,000		195,000	253,500	330,000
10	RM-7A	Pipe	Butterfield Blvd	E. Dunne Ave. to E. Main Ave.	21	Replace	2,800	260	728,000		728,000	946,400	1,230,000
11	RM-7B	Pipe	Butterfield Blvd	E. Main Ave. to Central Ave.	21	Replace	1,050	260	273,000		273,000	354,900	461,000
	Hill-Barrett Trunk												
12	HB-1A	Pipe	Barrett Ave.	Railroad Ave. to e/o US Hwy 101	18	Replace	3,350	220	737,000		737,000	958,100	1,246,000
13	HB-1B	Casing[1]	Barrett Ave.	Crossing under US Hwy 101	18/38	Replace	350	530	185,500		185,500	241,150	313,000
14	HB-2	Pipe	Barrett Ave.	w/o US Hwy 101 to Hill Rd.	15	Replace	5,750	190	1,092,500		1,092,500	1,420,250	1,846,000
	Hale-Monterey Trunk												
15	HM-1A	Casing[1]	E. Main Ave.	Crossing under RR	18/38	Replace	80	530	42,400		42,400	55,120	72,000
16	HM-1B	Pipe	E. Main Ave.	Depot St. to Monterey St.	18	Replace	750	220	165,000		165,000	214,500	279,000
17	HM-1C	Pipe	W. Main Ave.	Monterey St. to Hale Ave.	18	Replace	1,400	220	308,000		308,000	400,400	521,000
18	HM-2	Lift Station	Hale Ave.	Update Existing Lift Station H	700 gpm with Standby Capacity					300,000	300,000	390,000	507,000
	Cochrane Trunk												
19	CH-1	Pipe	Cochrane Ave.	Monterey to Butterfield Blvd.	18	Replace	1,550	220	341,000		341,000	443,300	576,000
20	CH-2	Lift Station	Cochrane Ave.	Cochrane Ave. and Monterey Rd.						250,000	250,000	325,000	423,000
	Other												
90	Radio Telemetry for Sewer Facilities									note 6			note 6
	Sewer mains rehabilitation and upgrades									note 6			note 6
	Infiltration and Inflow Reduction Program									note 6			note 6
											CIP Totals		**31,116,000**

Capital Improvement Program / Financing

No.	Phase I (2002-2005): 2002-03 ($)	Future	Existing	2003-04 ($)	Future	Existing	2004-05 ($)	Future	Existing	Phase II: 2005-10 ($)	Future	Existing	Phase III: 2010-20 ($)	Future	Existing	Financing: Future Users Benefit (%)	Total Capital Cost ($)	Future Users Cost ($)	Existing Users Cost ($)
1																			
1A							13,098,000	9,823,500	3,274,500							75%	13,098,000	9,823,500	3,274,500
2										811,000	405,500	405,500				50%	811,000	405,500	405,500
3										651,000	325,500	325,500				50%	651,000	325,500	325,500
4										4,394,000	2,197,000	2,197,000				50%	4,394,000	2,197,000	2,197,000
5										1,960,000	980,000	980,000				50%	1,960,000	980,000	980,000
6													1,272,000	636,000	636,000	50%	1,272,000	636,000	636,000
7													91,000	45,500	45,500	50%	91,000	45,500	45,500
8										1,035,000	517,500	517,500				50%	1,035,000	517,500	517,500
9							330,000	165,000	165,000							50%	330,000	165,000	165,000
10				1,230,000	615,000	615,000										50%	1,230,000	615,000	615,000
11							461,000	230,500	230,500							50%	461,000	230,500	230,500
12				1,246,000	623,000	623,000										50%	1,246,000	623,000	623,000
13							313,000	156,500	156,500							50%	313,000	156,500	156,500
14							1,846,000	923,000	923,000							50%	1,846,000	923,000	923,000
15										72,000	36,000	36,000				50%	72,000	36,000	36,000
16										279,000	139,500	139,500				50%	279,000	139,500	139,500
17										521,000	260,500	260,500				50%	521,000	260,500	260,500
18										507,000	253,500	253,500				50%	507,000	253,500	253,500
19	576,000	432,000	144,000													75%	576,000	432,000	144,000
20	423,000	317,250	105,750													75%	423,000	317,250	105,750
90																			
CIP Totals	**999,000**	749,250	249,750	**2,476,000**	**1,238,000**	**1,238,000**	**16,048,000**	**11,298,500**	**4,749,500**	**10,230,000**	**5,115,000**	**5,115,000**	**1,363,000**	**681,500**	**681,500**		**31,116,000**	**19,082,250**	**12,033,750**

12033750.00
18333000.00

Notes:
1. Proposed casings size and carrier pipe size.
2. Lift Station pricing can vary widely with site conditions.
3. Baseline Construction costs plus 30% to account for unforseen events and unknown conditions.
4. Estimated Construction Cost plus 30% to cover other costs including; engineering, administration, construction inspection, and legal costs.
5. Land acquisition costs, which may be required for some of the proposed improvements, can widely vary and are NOT included in this capital improvement program.
6. This project was included in the City's 5-Year Capital Improvement Program. Per City directions, and since this project has been funded in FY 2001-2002, the capital cost is not shown on this CIP schedule. See SCRAW Budget.